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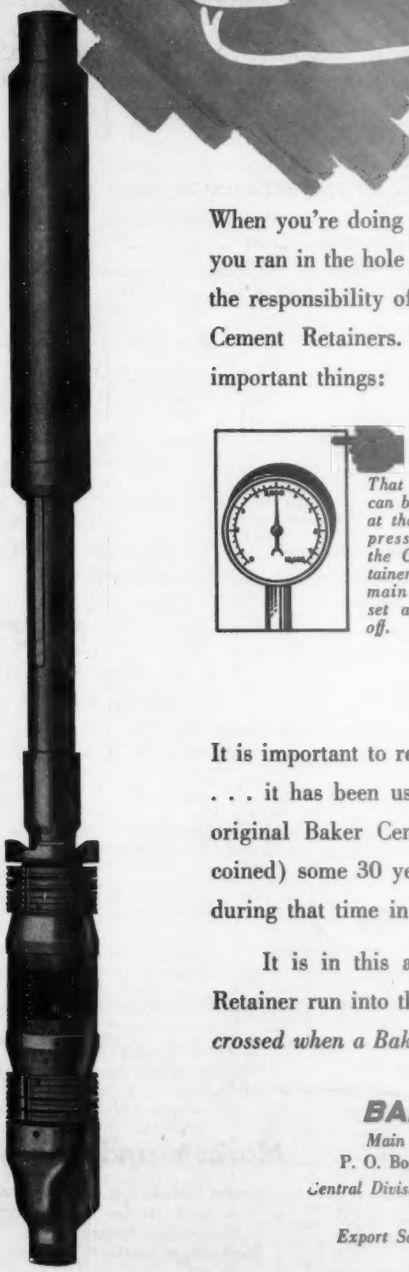

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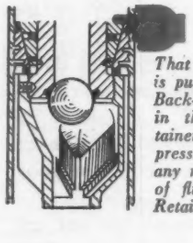

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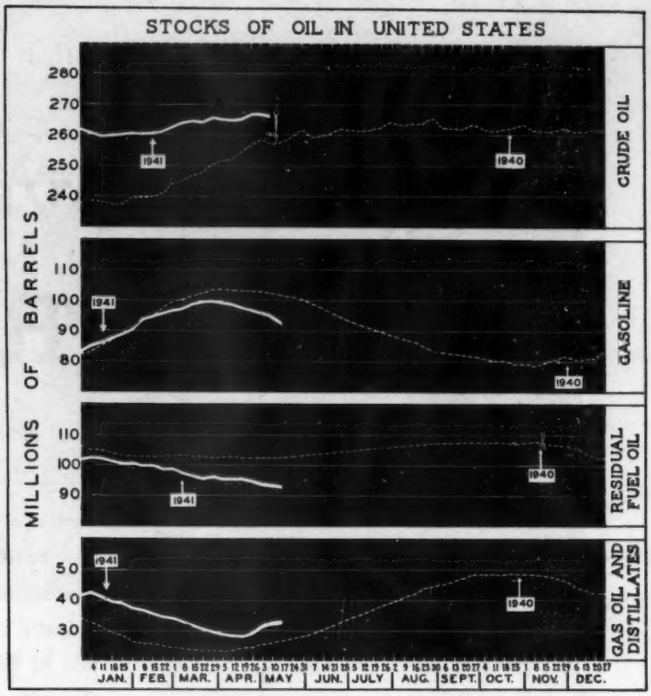
BAKER CEMENT RETAINER

Trends

Market Strength Brings Expected Crude Increases



THE expected advances in posted crude-oil prices in the Southwest and Middle West got under way the first of the week when a 10-cent increase became effective in Oklahoma, Kansas and Illinois, with a 9-cent rise in the Texas Panhandle. Details of the price boosts in all areas will be found on Page 48 of this issue. The latest advances are the result of a general strengthening of refinery markets centering in gasoline, with quotations on most refinery products now higher than they were a year ago.

CRUDE PRODUCTION *3,794,405 bbl. daily average—up 45,670 bbl. One year ago 3,845,683 bbl.*

CRUDE STOCKS *263,994,000 bbl. as of May 10—down 1,734,000 bbl. One year ago 257,079,000 bbl.*

GASOLINE STOCKS **94,867,000 bbl. as of May 17—down 836,000 bbl. One year ago 102,167,000 bbl.*

RESIDUAL FUEL-OIL STOCKS *93,987,000 bbl. as of May 17—down 420,000 bbl. One year ago 102,785,000 bbl.*

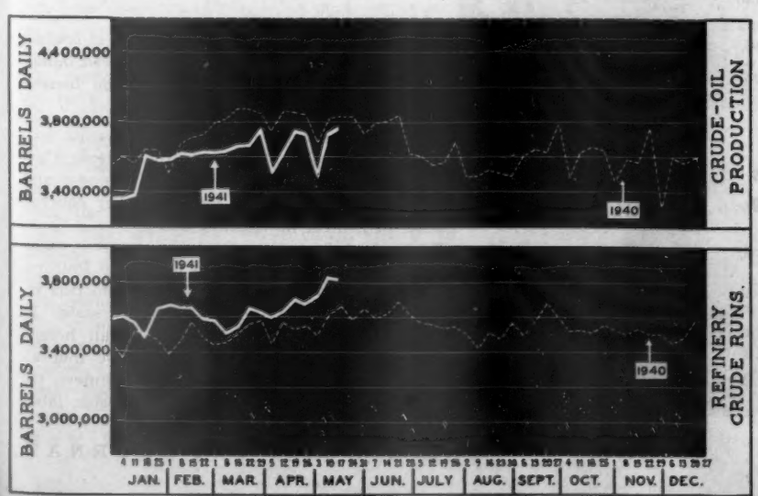
GAS OIL AND DISTILLATES *31,882,000 bbl. as of May 17—up 334,000 bbl. One year ago 26,706,000 bbl.*

REFINERY RUNS *3,805,000 bbl. daily week ended May 17—down 16,000 bbl. One year ago 3,665,000 bbl.*

*Includes 7,252,000 bbl. aviation motor fuel, up 63,000 bbl. Year ago 5,351,000 bbl.

The market situation is particularly strong in the Mid-Continent and Middle West where the latest increases originated. The requisitioning of tankers for British service explained last week has widened the demand for crude oil and refinery products available at interior points. Oklahoma and Illinois production has leveled off and the increase this year in Kansas output is of minor importance when compared to the decline of the past 8 months in Illinois production. Demand for crude oil from large and small buyers far exceeds the supply. Gasoline in the area served by these three states occupies the strongest statistical situation in several years.

In a few days it is expected that the details of the largest single pipeline project in the industry's history will be announced. It is understood that the plans call for the immediate construction of a 24-in. crude-oil line extending from one or more Texas points to the New York City area. It is also known that the several major companies which will participate in this project have under consideration the laying of a second line for the movement of refinery products.



DAILY AVERAGE PRODUCTION FOR WEEK

	May 17, 1941	Bur. Mines May est. of demand	May state allowables	May 10, 1941
Arkansas	75,770	83,900	76,673	72,500
California	641,150	598,100	571,000	637,925
Eastern fields	110,830	126,200	.....	109,320
Illinois	322,100	336,100	.....	324,045
Kansas	218,200	213,900	217,900	196,850
Louisiana	314,320	320,300	320,324	308,980
North Louisiana	*71,820*	.....	.....	*71,580*
Louisiana Gulf Coast	*242,500*	.....	.....	*237,400*
Michigan	38,405	40,000	.....	37,825
Mississippi	31,940	22,900	.....	31,230
Nebraska	4,400	4,800	.....	4,500
New Mexico	115,430	113,900	114,000	115,040
Oklahoma	415,400	440,000	400,000	412,450
Rocky Mountain states	103,160	117,400	.....	100,620
Texas	1,403,300	1,382,200	1,417,222	1,397,450
East Texas	*373,700*	.....	.....	*373,800*
West Texas	*256,900*	.....	.....	*248,950*
North Central Texas	*129,250*	.....	.....	*129,350*
East Central Texas	*78,000*	.....	.....	*78,000*
Texas Panhandle	*78,500*	.....	.....	*82,500*
Texas Gulf Coast	*393,700*	.....	.....	*392,950*
Southwest Texas	*93,250*	.....	.....	*91,900*
Total United States	3,794,405	3,799,700	.....	3,748,735
Total production, Jan. 1-May 17, 1941		470,980,850 bbl.		
Same period last year		488,783,836 bbl.		

The sizes mentioned for this line are 14, 16 or 18 in. The crude line will have a capacity of 300,000 bbl. daily and product line from 60,000 to 150,000 bbl. daily, depending on the size.

These lines are to furnish a transportation offset to the 50 oil tankers which have been requisitioned for British use, most of which will be taken from the Gulf Coast-Atlantic seaboard service.

The concern of many operators at this time is how to offset the transportation shortage while the pipe lines are being completed. Surveys are being made of all pipe-line, inland-waterway and railroad-transportation facilities which could be used in transporting Texas and Louisiana crude oil and refinery products north and east. If these combined facilities are inadequate, it is apparent that eastern markets will be short of their requirements by late summer or early fall and rationing may result. Producers and refiners who look to the Gulf Coast for outlets are fearful as to market reactions.

Oil State Governors Warn A.P.I. Members of Regulation Dangers

By H. STANLEY NORMAN

Technical papers and digests covering new developments and practices in the producing and refining branches of the industry are presented in the A.P.I. Section of this issue starting on Page 62. Committee reports and technical papers constitute the major activity at the mid-year meetings of the Institute, which has developed into the "working session" of the organization.

TOPICS not on the agenda competed here this week for the interest of oil men from all sections of the country attending the annual midyear meeting of the American Petroleum Institute. More than 1,200 oil men registered for the meeting which opened last week end with committee sessions and continued through Thursday.

General interest was largely focused on the transportation deficiency developing on the eastern coast because of its potential relation to every phase of petroleum-industry operations. Producers in Texas are intensely interested in how the transportation blockade will affect demand for crude oil. They were not alone in their concern. At least until other provisions can be made, the demand for crude backed up in Texas by diversion of 25 tankers to British service will revert to Oklahoma, Kansas, Illinois, and other Mid-Continent and middle-western producing states.

Hundreds of scientists attending the midyear meeting were complacent about the transportation problem, feeling that the industry's management would solve it with the same dispatch with which others have been overcome. They declined to have their interest diverted and devoted their full attention to technical questions. Divisions of Production and Refining devoted 2 days to group sessions at which papers were presented on general and special operating practices.

W. R. Boyd, Jr., executive vice president of the Institute, who was delayed in reaching Tulsa until May 20 because of discussions in the East on the transportation situation, urged that the industry be given a "green light" in dealing with the problem.

"If permitted by the Government, if given a free hand to operate," declared Mr. Boyd in a statement here, "the industry's record after the war situation has passed will be commendable."

"Developments may indicate, however," he said, "that the petroleum industry must be given the patriotic privilege of constructing at its own expense and operating facilities for the transportation of its products. The industry is ordering new tank ships, and is discussing plans for the construction of new pipe lines. Some projected lines in the Southwest have encountered opposition from the railroads which have prevented crossing rights in places where the right of eminent domain does not exist under state law."

Remarks regarding the possible extension of pipe-line facilities referred to the projected line from the Southwest to the eastern seaboard discussed on Pages 40 and 54 in this issue.

Gov. Leon C. Phillips of Oklahoma and Gov. Payne Ratner of Kansas were the featured speakers from outside the industry. Both governors spoke at the Wednesday afternoon session and reaffirmed their appreciation and friendship for the oil industry which contributes an important share of the wealth in both states. Both sounded warnings of the danger of federal encroachment on the management of the petroleum industry. Governor Phillips reviewed work of the Interstate Oil Compact Commission and expressed appreciation for the thoughtful conclusions drawn by the Cole submittee in its preliminary report to Congress.

Governor Ratner, who was described by Governor Phillips as "an able exponent of state sovereignty," reviewed trends in the federal Government's relationship with private business and called for militant opposition to further centralization of control in Washington.

"As one of the major oil-producing states, Oklahoma is oil-minded," declared Governor Phillips. "I offer no apology for my friendship to this industry, which means so much to my state. In fact, I am an unashamed friend of all honest business and industry. I do not believe that all business is sin and all business men sinners. On the contrary, I believe that free enterprise, labor

Right: R. P. Anderson, New York, secretary of the A.P.I. Refining Division and Carl A. Young, Dallas, Tex., secretary of Production Division, prolonging their conversation in one of the committee-conference rooms

Left: Victor H. Scales, New York, director of A.P.I. public relations, looking on while Lacey Walker, New York, secretary and assistant treasurer of the Institute, arranges a meeting detail

Left, bottom: H. N. Blakeslee, director of institute safety work, conferring with J. E. Stillwell, Dallas, Tex., staff engineer in the Production Division

CHAIRMEN WHO PRESIDED AT GENERAL SESSIONS OF THE A.P.I. MIDYEAR MEETING . . .

Cary R. Wagner, Pure Oil Co., Chicago, presiding officer at the refinery session on fuel economy in refining operations

R. W. French, Continental Oil Co., Los Angeles, Calif., presiding at Division of Production session dealing with well operations

R. D. Wyckoff, Gulf Reseach & Development Co., Pittsburgh, Pa., presiding at a Production Division meeting on cores and sands

Paul D. Torrey, Sloan & Zook Co., Houston, Tex., presiding at a meeting on drilling and production practices

H. W. Camp, Cities Service Oil Co., Bartlesville, Okla., presiding at a Refining Division meeting dealing with fuels

and industry should be encouraged to insure the future welfare and prosperity of the state and nation.

"We are faced today with grave problems. Our national existence is threatened, and we are engaged in gigantic preparations to defend our way of life.

"I have stoutly maintained that the oil industry was fully prepared and ready to do its share to meet any national emergency. This question has now been fully investigated, publicly debated and officially tried. The petroleum investigating committee of Congress, in its preliminary report, has found the oil industry ready to meet 'any conceivable demand for national defense."

Reviews Cole Committee Actions

Governor Phillips then sketched actions of the Cole committee through its "painstakingly conducted extensive hearings," through its tours of inspection in the nation's oil fields and through the preliminary report following the interstate-oil-compact meeting in New Orleans, La. Then he expressed gratitude over the Cole committee preliminary report in which findings were summed up in these words: "Suffice it to say that our observation of what the oil industry is doing and is prepared to do in behalf of national defense gives assurance and courage to all who are interested in our national security and defense. The oil industry can be depended upon to do its patriotic part in fulfilling whatever part is laid upon it in the days that are ahead."

Referring further to work of the Compact Commission, Governor Phillips said: "We have expanded our educational program by the work of our three fine committees: legal, engineering and regulatory practices. These committees, composed of leading technical and legal minds of the nation, have spent many months in their studies and have prepared and presented to the commission very outstanding and thorough reports. There is yet much to be accomplished by these committees and it is our plan for them to continue their studies and submit supplemental reports from time to time.

"In this connection we invite constructive criticism and suggestions concerning these reports. The final reports of these committees will then contain the most thorough and informative data anywhere available. They will be of inestimable value to the federal Government, to the regulatory bodies of the states and to the industry itself."

Kansas' opposition to excessive imports was placed in the record by Governor Ratner.

"The excessive imports of cheap farm products and cheap petroleum tend to keep down prices for our own domestic output," he declared. "In the past, we in Kansas have vigorously opposed unnecessary and unwise importation. We shall continue to resist whenever the occasion demands.

"Another grave danger," continued Governor Ratner, "has been the attempt to force federal control upon the oil industry.

"While it may seem that the threat of federal control has subsided, and that we have had a part in a successful fight to preserve state sovereignty with respect to proper regulation of the oil industry, we can't afford to sleep on the shield of victory. We must continue to be alert against any and all future threats.

"We must be on guard against injurious foreign imports," he added.

The scheduled conference on Wednesday between Governor Ratner of Kansas and the representatives of crude-oil purchasers lost much of its potential interest when several buyers advanced postings 10 cents per barrel in Oklahoma, Kansas, and Texas Panhandle and parts of Illinois. Governor Ratner was prepared to show how the increasing costs of producing oil because of higher taxes, wages and prices of equipment make it essential for the producer to receive more for his crude.

Transportation Restrictions Have Sharp Effect

Deficiency of transportation facilities from the Gulf Coast to eastern markets because of government diversion of tankers to British service has placed a new buying pressure on Mid-Continent production. Capacity utilization of inland transportation facilities to cushion the shock of coastwise tanker deprivations has increased demand for crude in Mid-Continent and middle western producing states. Purchasers apparently moved crude prices higher May 19 to protect their connections from buyers seeking abnormal supplies of oil in the Mid-Continent district.

The social highlight of the midyear meeting was the dinner and entertainment Wednesday night presented by the Tulsa oil and supply companies. The dinner was the only social event scheduled of an all-institute nature. The annual golf tournament was conducted over the Southern Hills Country Club course during the 4-day meeting but participants made up a comparatively small per cent of the total attendance. Arrangements for the dinner and golf tournament were made by a committee headed by D. E. Buchanan, Tulsa, vice president of Hanlon-Buchanan, Inc.

Four general sessions for the Division of Production were held Wednesday and Thursday. Presiding at the production meetings were M. H. Parks, P. D. Torrey, R. D. Wyckoff and R. W. French.

Three general sessions for the Refining Division were conducted by C. R. Wagner, L. L. Davis and H. W. Camp.

Directors of the Institute met Wednesday.

Members of nearly 65 committees and subcommittees met to discuss practically every operating problem in the producing and refining divisions.

Octane Race Halt Asked

Concern was evidenced by many of the refinery technologists here for the meeting regarding the acceptance of the octane value of a gasoline as an index of its efficiency. Octane number can be misleading was the general opinion among many technologists. Some went further and cited instances in which fuel of lower laboratory octane rating operated more economically than fuels of higher value.

Just how far the refining industry may go in the octane race is of course a matter for the refiners themselves to decide, but an important review of the situation should be obtainable from the automotive fuels survey committee which reports to the central A.P.I. refining committee. K. G. Mackenzie, Texas Co., chairman of the committee, and Dr. T. G. Delbridge, director of research for the Atlantic Refining Co., supported by Dr. J. B. Rather of Socony-Vacuum and Dr. D. P. Barnard of the Standard Oil Co. of Indiana, all agreed there was a declining benefit to come from advancing octane values of ordinary motor fuels and that the point had already been reached in the ascent where refiners should question the advantages of producing motor fuels of still higher octane value. They asked that the average consumer be convinced of the true scientific facts in the case whereby the motorist would accurately weigh the relative advantages of buying a higher-octane gasoline for his car against buying a grade of lower-octane value and price. They sought to stress the economy of buying the lowest-octane-value gasoline on which the car would not knock.

Tanker and Pipe-Line Developments . . .

- Fifty American tankers representing approximately 250,000-bbl. daily transporting capacity are being requisitioned for British use. Most of these tankers will be taken from Gulf Coast-Atlantic seaboard service where 260 tankers are required to transport crude-oil and refined-product shipments totaling 1¼ million barrels daily.

- Plans are being completed for the construction of a 20 to 24-in. pipe line from Texas to New York City area by several companies. A large product line—possibly 18-in.—is also under consideration. Financing has been arranged and the pipe line can be made available by mills through changes in priorities. This cooperative project must be approved by Department of Justice and arrangements made for right-of-way from railroads which have opposed pipe-line projects in southeastern states.

- Plans have been completed for construction of 12-in. crude line from Portland, Me., to Montreal, Canada.

- Expect construction of line of Plantation Pipe Line Co. from Baton Rouge, La., to southeastern points to be under way in the near future. Pipe sizes have been increased.

- Most of the new pipe-line construction will require 6 or more months to complete. In the meanwhile possibilities of tank cars, barges, trucks and every other form of transportation between southwestern and eastern points are being investigated with the view of offsetting transportation losses caused by requisitioning of tankers.

- Additional information having to do with the latest pipe-line developments will be found on Pages 44, 45, 162 and 163 of this issue.

Plan 300,000-Bbl. Crude Line, Texas to Eastern Points

By J. P. O'DONNELL

NEW YORK, May 20.—Construction of a 20 to 24-in. national-defense line to transport crude oil from Texas fields to East Coast refineries, a refined-products line from the Gulf to eastern consuming centers, or both, is now generally regarded as the solution to the problem arising from the diversion of United States tankers from domestic to British service. Preliminary surveys of both existing and possible alternatives indicate that while they could, in aggregate, contribute a fair volume of crude oil and refined products to the East Coast it would be far from adequate and that some means of moving a substantial volume must be found.

A 24-in. line would have a capacity of 250,000 to 300,000 bbl. per day which would be sufficient to meet 20 to 25 per cent of current East Coast requirements. It would also effect the release of more tankers than all readily apparent alternatives including the construction of links in existing pipe-line systems. Tankers are capable of moving an average of from 3,500 to 5,000 bbl. of oil per day from the Gulf to East Coast. Therefore, a pipe line with a capacity of 300,000 bbl. would release from 60 to 85 tankers.

This number would be more than sufficient to meet the immediate needs of the British as indicated by the 50-tanker allocation and would also make it possible to meet further demands which are regarded as inevitable. A request for another 25 tankers is anticipated. Should this country enter the war, demands of the Navy for additional oilers will require tankers now in coastwise service.

Numerous Barriers to Hurdle

Whether or not construction of this line will be undertaken depends on a number of things. The past record of the oil industry, particularly during World War 1, indicates that it would undertake the task immediately, if called upon to do so. However, there are a number of barriers which it would be necessary to remove before the project emerges from the "talking stage" in which it has been since last fall.

The biggest barrier to a pipe line from the Gulf of Mexico to the East Coast, which incidentally has been advocated by Dr. R. E. Wilson, petroleum consultant to O.P.M. since the first indication of possible transportation difficulties, would be railroads. The railroads, incapable of handling anything but a minute fraction of Atlantic seaboard requirements, have successfully delayed southeastern lines and thereby accelerated the threatened shortage. The Plantation pipe line from Baton Rouge, La., to Greensboro, N. C., one of two southeastern lines, was originally designed as an 11, 9, 6, and 4-in. system with capacity of 48,000 bbl. per day. Diameter will be raised to 12, 10, 8, and 6 in. with substantially larger capacity.

Must Secure Several Approvals

Approval of the Interstate Commerce Commission would be necessary since the line would meet with most strenuous opposition from railroads. Approval of the Army and Navy would be necessary, especially that of the War Department, since the line would cross a number of navigable rivers and streams. Approval of the Office of Production Management would be necessary, particularly in the case of priorities since a large quantity of steel would be required.

Finally but possibly most important is the approval of the Department of Justice. Cost of building the line probably would be $80,000,000 to $90,000,000 and would require the cooperative effort of possibly 10 or 12 companies. Cooperation of this type is regarded as being of questionable legality in light of Department of Justice interpretations of antitrust legislation as exhibited at Madison. If approval of the project is forthcoming from federal agencies and priority in securing necessary material is assured, the oil companies, it is believed, would move immediately toward construction of the line. This would be particularly true if it were made possible for the companies to amortize the cost on a basis similar to that by which other industries are paying for defense plants.

Construction Time

Estimates of the time required to lay a 24-in. pipe line vary from 6 months to 1 year, depending on rate of pipe delivery. It would quadruple the volume of crude which is now being delivered and which could be delivered if "bottleneck" lines across Ohio to connect with trans-Pennsylvania gasoline lines were to be constructed. Pipe-line movement of crude to the East Coast as a result of recent increases now totals 45,000 bbl. per day; 24,000 bbl. per day to Standard Oil Co. of New Jersey at Bayway from East Texas, southern Arkansas and northern Louisiana; 10,000 bbl. per day to Gulf Oil Corp. at Philadelphia from Oklahoma and 11,000 bbl. per day to Tide Water Associated Oil Co. at Bayonne from the Pennsylvania fields. Construction of lines across Ohio and utilization of Pennsylvania lines would increase deliveries to the East Coast at most another 55,000 bbl. Adding this to present movement would make the total 100,000 bbl. per day, a total that would be increased to 400,000 bbl. per day by the Texas-East Coast line.

Besides the 45,000 bbl. now moving to the East Coast by pipe line, another 5,000 to 6,000 bbl. per day is being delivered by barge to Socony-Vacuum Oil Co., Inc.'s refinery at Long Island, N. Y. By this means Socony-Vacuum effects the release of another tanker. This method of delivery was made possible by increasing throughout of line supplying Socony-Vacuum's refinery at Buffalo, N. Y., with Mid-Continent and Illinois crude. From Buf-

(Continued on Page 52)

Recent Increase in Drilling May Bring Year Above 1940

By W. V. HOWARD

AFTER lagging below 1940's drilling activity for the first 3 months, completions increased 35.4 per cent above March's record during April, thus bringing the first 4 months of the current year within shooting distance of last year's record. The Oil and Gas Journal's weekly reports show that activity during May is running slightly ahead of last year's peak month, which was also May.

Comparing this year's record with that of last year, a number of interesting developments may be noted, especially if considered in the light of trends during the past 4 months. In the Appalachian area, recent price increases have spurred drilling and April's completions were 26 per cent above those of March. The year's record to date is almost exactly equal to that of last and the recent increase in activity will probably carry 1941's completions above 1940's. Ohio is already ahead of last year by 21 per cent, due in great part to the extensive search for gas. Indiana is ahead of last year because of wildcatting and the drilling up of the Griffin and New Harmony areas. Kentucky has started on one of the most strenuous periods of development in the state's history, with the eastern gas areas the prime objective. As one company alone has over 40 wells on the way down, Kentucky's peak is not yet in sight.

Change in Illinois Play

Illinois is running 5 per cent behind last year, but this deficiency may soon be made up. During 1940, Louden was being drilled up and the Devonian play at Centralia and Salem reached its peak and declined. In April 1940, 207 out of a total of 290 completions were in these three fields. In April 1941, these three fields contributed 12 out of Illinois' 314 completions; the deepening operations to the Trenton at Salem are not included as these are considered "recompletions" rather than "completions." The most active fields in Illinois today are Allendale (with 13 completions in April); Benton, 20; Calvin, 28, Hoodville, 26; Mount Carmel, 40; New Harmony, 20; Patoka and East Patoka, 10, and West Liberty, 17. These are all sand fields with the exception of West Liberty, and none of them has reached its limit. Already some operators are talking of Benton as another Salem and the string of pools along the banks of the Wabash is continually growing. This new activity is keeping Illinois very definitely in the picture and the drilling trend is still upward.

The situation in Michigan is not as optimistic. Continued wildcatting has met with unfavorable results and Michigan is the one state east of the Mississippi in which the future looks worse than at this time last year.

Upper Mid-Continent

The picture in the northern Mid-Continent area is very different from that of last year. The Forest City basin play is restricted almost entirely to the area around Falls City, Neb. Kansas and Oklahoma have almost exactly reversed their positions with a tendency for both states to become somewhat more active. The price increase has had something to do with this tendency, but the most important factors are Oklahoma's need for new production and Kansas' inability to find the limits of the production she has. No field in Kansas is particularly active, but a roll of the most active ones reads more like a list of 1935 activity than of 1941. Expressed somewhat differently, it takes Kansas operators 6 to 10 years to drill up their larger fields under present marketing conditions. Thus, the active fields are Edwards, discovered in 1936; Geneseo, 1934; Hall-Gurney, 1931-35; Lost Springs, 1926; Trapp, 1931; and Zenith, 1937. In Oklahoma, the activity is in newer pools, such as Droppleman and West Hewitt, with considerable drilling promised in Guthrie, Tecumseh Lake and other recent discoveries. If there are no important discoveries Kansas will probably increase its lead over last year, while Oklahoma continues to decline.

Texas Activity Increasing

With the exception of East Texas, all the major subdivisions of the country's greatest producing

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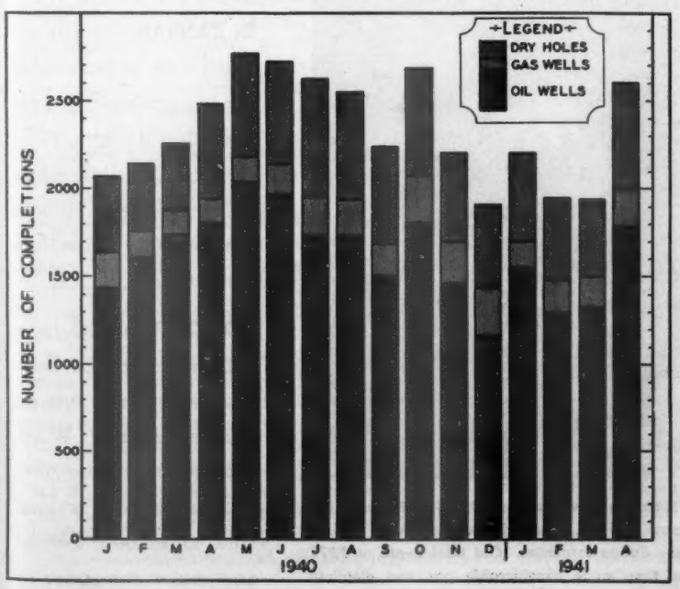
TABLE 1—RECORD OF COMPLETIONS IN THE UNITED STATES

Area—	First 4 months 1940	First 4 months 1941	Jan. 1941	Feb. 1941	Mar. 1941	Apr. 1941	Per cent change First 4 months Inc.	Per cent change First 4 months Dec.
N. Y., Pa. and W. Va.	1,626	1,627	343	389	390	505	....	....
Ohio	380	460	122	96	110	132	21	....
Indiana	110	143	38	25	34	46	30	....
Kentucky	129	182	51	44	36	51	41	....
Illinois	1,009	955	249	210	182	314	....	5
Michigan	395	275	67	76	52	80	....	30
Kansas	469	524	156	112	121	135	12	....
Oklahoma	547	450	129	103	87	131	....	20
Nebraska	1	26	10	3	3	10	2,500	....
Missouri. Iowa	11	2	0	0	0	2	....	81
North Central Texas	1,008	890	209	200	187	294	....	22
West Texas	709	624	158	128	152	186	....	12
Texas Panhandle	191	161	43	33	36	39	...	16
Eastern Texas	212	382	111	71	74	126	80	....
Texas Gulf	418	358	75	97	98	88	...	14
Southwest Texas	682	605	158	138	128	181	....	11
Total Texas	3,220	3,020	754	667	674	924	....	6
North Louisiana	181	185	48	41	49	47	2	....
Louisiana Gulf	328	276	78	60	57	81	....	16
Total Louisiana	509	461	126	101	106	128	....	9
Arkansas	62	53	14	11	16	12	...	15
Mississippi and SE	57	71	13	10	22	26	25	....
Montana	45	77	27	19	11	20	71	....
Wyoming	52	44	13	10	12	9	....	15
Colorado, Utah	5	14	2	6	5	1	180	....
New Mexico	272	88	29	16	19	24	....	67
California	356	334	119	69	63	83	....	6
Total United States	9,255	8,806	2,262	1,967	1,944	2,633	....	....

Fig. 1—Chart showing completions by months, January 1940 to April 1941



SPARKS . . . FROM THE NEWS

NEW NOTE: A new note was struck by refinery technologists at the Tulsa A.P.I. meeting. They want lower octane ratings, not higher. Here is a basis for argument with engine designers.

THE ANSWER: For years engineers have wondered how they operate a large-diameter pipe line and executives have wondered if it would pay off. It now appears that all questions will be answered by a new Texas-East Coast line.

WAR SHADOWS: The first World War brought about the formation of the A.P.I. Developments in the present conflict as they affect oil was the principal topic of discussion at the semiannual meeting in Tulsa this week.

MORE FOR BUSINESS: About 56 per cent of the man-miles traveled in the United States is in the interest of business and 80 per cent is done in privately owned automobiles. This is a sound index with which to answer "Who buys the gasoline and oil?"

EVIDENCE: Producers said they would make more crude oil available when it was needed. The substantial upturn in drilling over the past 6 weeks supports their statement.

REVERSED TREND: Indications now are that crude production during the last 6 months of the year will be as much above last year's output as the first 6 months fell below it.

SUDDEN DEATH: Oklahoma's Governor Leon C. Phillips hinted that he did not approve of the lobby urging passage of the proposed secondary-recovery unitization law in Oklahoma City and the measure died without further ado.

DROPPED: Conversion of natural-gas lines to oil service as a solution to transportation problems of the oil industry was dropped when it was discovered that the gas industry needed more pipeline capacity, not less.

ARGUMENT ENDED: The State of Nebraska has paid the $15,000 bonus to the company discovering the first commercial production in the state at Falls City—which ends the arguments as to whether the Cornhuskers would ever pay off the successful wildcatter.

OUT IN FRONT: Private passenger cars amassed a total of 500-billion passenger-car miles in the United States last year which is seven times that shown for all other forms of transportation combined according to an automobile authority.

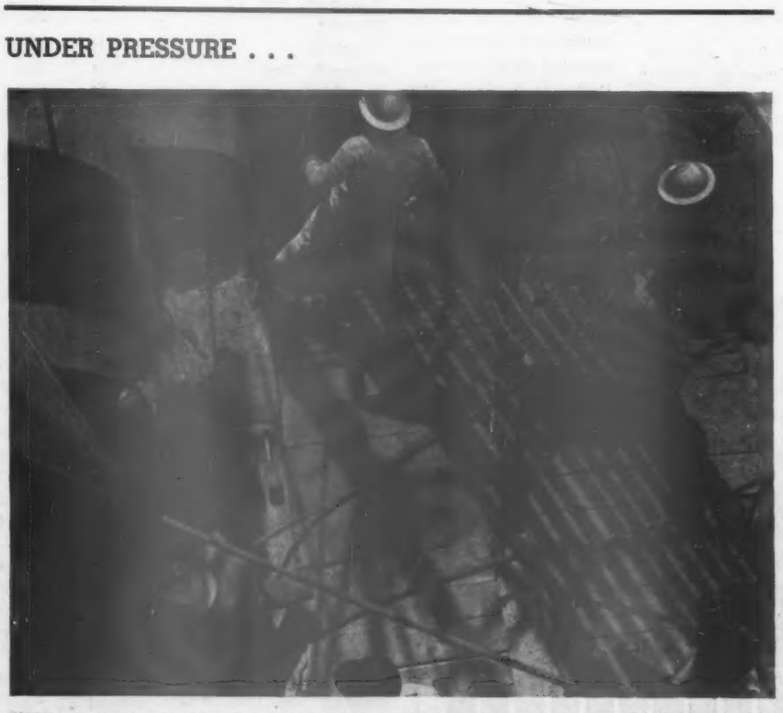
TRANSPORTATION: With transportation the principal problem of the industry, oil companies are casting an appraising eye at every boat capable of carrying a few barrels of oil. A sales manager fears that the appraisals will eventually include his private launch and rowboat.

DELAYED EXCITEMENT: According to latest reports from Louden, the long-heralded Devonian production in that Illinois' field is still undecided.

IN KANSAS: Kansas operators are so busy making big pools out of little ones that the state Corporation Commission has to hustle to keep up with nomenclature and proration divisions.

NO ECLIPSE: The independent in the oil business is not going into an eclipse. A Fort Worth operator has more than 50 rigs drilling, a total said to exceed that of any major company.

UNDER PRESSURE . . .



Running drill pipe in the hole under pressure on Michigan's deepest test, the Gulf Refining Co. 1 Bateson in Bay County, Michigan. The well is now 7,789 ft. in a sidetrack hole with 17.5-lb. mud being needed to control the gas pressure in the Salina formation. Old total depth of 7,776 ft. was reached last December. The well at one time made considerable gas and distillate

Prospects for Quick Settlement Of Antitrust Suit Fading

By HENRY D. RALPH

WASHINGTON, D. C., May 19.—Negotiations for settlement of the antitrust suit against the American Petroleum Institute and 22 major oil companies resume here this week after an interval to permit oil-company attorneys to take vacations.

Prospects for settlement of the suit by consent decree, however, look less bright than they did a few weeks ago when active negotiation was suspended, and Department of Justice attorneys are preparing to bring the case to trial if and when negotiations finally break down. The date for filing answers to the complaint with the federal District Court here has again been postponed to July 1, and, as in the case of the last 30-day postponement, the defendants were told that this is positively the last extension.

Several reasons are given for the belief that prospects for early settlement are fading. One is that some of the department attorneys do not want to settle by a decree which gives the department anything less than is asked in the bill of complaint. By thus holding out for everything asked originally they put the oil companies in the position of having nothing to lose and something to gain by a trial of the case. Every time defense counsel brings in a proposition the department attorneys mull over it carefully and hunt for "jokers" or points which the oil companies could claim as a victory, and the longer the negotiations drag out the tougher the department gets.

The same sort of suspicion exists among the negotiating committee of the defense counsel. Language of a paragraph of a proposed decree may be discussed in great detail in an attempt to decide just how each side would interpret and apply it, and the conclusion frequently is that there is no meeting of minds no matter how the wording is revised.

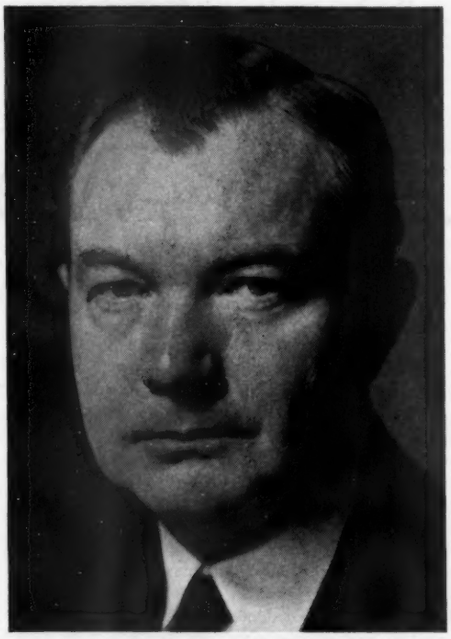
Ready to Press Elkins Act Suits

One thing that was counted on to force an early settlement is the series of Elkins Act suits charging pipe lines with giving illegal rebates to the majors in the form of dividends to their shipper owners. The department is ready to try the first three test cases immediately as there seems to be no dispute on the facts and the only issue is one of law. Department attorneys are supremely confident that the law is all on their side, and they express the view that the company attorneys privately feel the same way. Settlement of the Elkins Act cases was one of the conditions for settlement of the A.P.I. "Mother Hubbard" case, but it now appears that the department will not yield at all on its Elkins Act stand so the major companies have little inducement to make concessions on the big case.

During the early stages of the negotiations there was discussion of some sort of formula for adjusting the amount of dividends paid by pipe lines to their major-company owners, but such formulas would be so complicated and require so much adjustment to changing conditions that the department probably will reject the idea and will insist that pipe-line divorcement is the only practical solution.

The divorcement problem will arise in Congress on June 5 when the Senate judiciary committee opens hearings on the three bills introduced by Sen. Guy M. Gillette of Iowa to force major oil companies to divorce themselves of pipe lines, tankers, and marketing facilities. It may develop into a race to see whether Congress or the courts attempt to force divorcement first.

Meanwhile there is a prospect that the oil industry may tangle with the Department of Justice over defense problems. Atty. Gen. Robert H. Jackson has laid down rather strict rules under which he will give limited sanction to industry



Atty. Gen. Robert H. Jackson, who has set forth a four-point program of cooperation between the American Petroleum Institute and the Office of Production Management

actions requested by the Office of Production Management or the Office of Price Administration and Civilian Supply. Both these offices are much concerned over the possibility of shortages of petroleum products in the Northeastern states as a result of the transfer of 25 oil tankers to the British service. The cooperation of the industry has been asked, but because of past experiences, both the industry and the Department of Justice are extremely wary of each other.

O.P.M. Seeks Cooperative Committee

O.P.M. has asked the oil industry to set up a committee to advise with it on defense matters, and the A.P.I. has appointed a temporary fact-finding committee. It is emphasized both at O.P.M. and the Department of Justice, however, that this committee is only temporary and can take no action. It will be necessary later to set up a formal committee with full government approval and to obtain formal clearance for every action.

This oil-industry defense committee, if and when established on an approved and working basis, can be of great value both to the industry and the Government in providing a legal channel for cooperation in meeting civilian needs for petroleum products. It can function much as the tanker defense committee is cooperating with the Maritime Commission in allocating 25 tankers for the British service.

The O.P.M., of course, is very anxious for the construction of additional pipe-line facilities between the Mid-Continent area and the North Atlantic states in general, to care for the deficiency in tanker capacity, but new pipe-line construction is made particularly difficult at the present time by the Department of Justice suits and the threatened congressional action to force divorcement. Some of the proposed pipe lines probably would not be economical to operate in competition with tankers in normal times, which is another reason why private capital may hesitate to construct more lines. To a certain extent this objection could be offset by a certificate from O.P.M. that new pipe lines are needed for national defense and that the investment may be amortized for income-tax purposes within 5 years; or it might be possible for the Government to finance some pipe lines under an emergency-plant facilities contract under which the operating company has an option to purchase the line at the end of 5 years if it has economic value at the time.

Justice Department Reserves Rights

The defense antitrust policy of the attorney general, as laid down in letters to O.P.M. and O.P.A.C.S., is that there is nothing illegal in conferences between industry representatives and defense agencies. A formal industry committee may be set up at the request of O.P.M. or O.P.A.C.S., but must confine itself to collecting information and may not determine industry policy, coerce compliance with government orders, nor go beyond the scope outlined by the Government. Responsibility for determining and enforcing policies rests with the government agencies. After a general industry program is determined, it must be filed with the Department of Justice, but thereafter detailed administrative steps need not be reported to justice. The department reserves the right to institute civil suits to enjoin acts not in the public interest.

Under this procedure, it is probable that the proposed oil-industry defense committee will insist that any plan for cooperative construction or use of pipe lines be worked out by O.P.M. and formally approved by the Department of Justice before any action is taken.

A. I. Henderson, deputy chief of the materials section of the Office of Production Management, recently sent a letter to the American Petroleum Institute making a series of about a dozen suggestions concerning action to be taken by the Temporary Industry Committee. However, neither the A.P.I. nor the O.P.M. would reveal the nature of the specific suggestions until such a time as a

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Construction of Socony-Vacuum Oil Co., Inc.'s gasoline pipe-line-system which connects the company's refinery at Buffalo with distributing points in western New York

With 1,000 miles of gasoline-pipe-line construction starting this month and with an additional 2,000 miles to be laid soon, product-line facilities in the United States are due to be increased by a third in 1941. Transportation costs for moving petroleum products by tanker, pipe line, railroad and truck are discussed to indicate factors responsible for building lines to meet different conditions in four distinct areas.

Extensive Gasoline Pipe-Line Program Under Way

By PAUL REED

WITH work scheduled to start this month on approximately 1,000 miles of gasoline pipe lines, the industry is entering the season of active construction in 1941 with a remarkable program for expansion of facilities for the transportation of refined products. This 1,000 miles of lines includes only projects for which definite arrangements are being made in the Kansas-Nebraska-Iowa-South Dakota area, Indiana, and New York State. In addition to these lines, there are projects which include uncompleted gasolines lines as well as gasoline lines in the advanced stages of planning in Pennsylvania, New York, Massachusetts and the southeastern states which represent a total of another 2,000 miles. This means that the country has good prospects of adding about 3,000 miles of gasoline pipe-line mileage before the end of the year. This will increase present gasoline pipe-line mileage by one-third since the mileage of systems now in operation is over 9,500 miles. Furthermore, within the last week certain major interests have been seriously discussing a new project, not yet announced, for a Gulf Coast-Atlantic seaboard line yet included in these figures.

Construction Is Pushed

These construction programs are being pushed in spite of the heavy load which has been placed on the steel industry. In some cases provisions were made for procuring pipe before the beginning of the construction season. In other cases, special arrangements will be made by the federal Government because of the importance of gasoline pipe-line construction in the national-defense program. Most of the mileage already contracted is for Standard Oil Co. (Indiana) and Socony-Vacuum Oil Co., Inc., projects. Standard Oil Co. of New Jersey, Shell Oil Co., Inc., and Sinclair Refining Co. have large projects which are expected to materialize soon.

For several years plans for some of the lines mentioned have been under consideration. This fact should be kept in mind in seeking an explanation for the accelerated pace of gasoline pipe-line construction programs this spring. The basic reason is the need for providing the most economical means of transportation in order to assure a good margin of profit in marketing petroleum products under competitive conditions which prevail. Notwithstanding the trouble encountered in the internal corrosion of gasoline pipe lines, experience in the operation of existing systems demonstrates that transportation of gasoline and refined products through pipe lines may be accomplished without losses due to leakage or evaporation. It is dependable and profitable. Through the development of modern equipment and methods, construction has been carried on recently at a faster rate and at a lower cost than was possible a few years ago. Within the past year there has been a widespread recognition of the special function of pipe-line transportation under wartime conditions. Pipe lines are safer from attack than other forms of transportation. Furthermore, pipe-line shipments in certain areas make it possible to release tankers for foreign or naval service.

Transportation Costs

In the industry there has been a growing appreciation of the fact that in some areas where petroleum products have been moved largely by barges and tankers, there are decided advantages in using pipe lines which are designed to meet the situation effectively. Executives of three major companies have arrived at substantially the same conclusions in independent studies of the comparative cost of tanker, pipe line, and railroad transportation for long hauls of from 1,000 to 2,000 miles. Roughly, it was found that tanker transportation costs a third as much as pipe-line transportation, while railroad transportation costs twice as much as pipe line. Railroad costs were figured as the actual ton-mile cost to the railroad. Rates charged were not taken into consideration. Actual railroad costs, of course, are hard to determine accurately because of the numerous factors which enter the problem. It was found that ton-mile transportation costs for petroleum products are as follows on a broad general average: railroad, 7 mills; pipe line, 3 mills, and ocean-going tanker, ¾ to 1¼ mills with 1 mill used as a convenient figure for comparison.

Transportation by truck has been found in other investigations to be 1.5 to 2 cents per ton mile on average hauls of 150 to 400 miles. Costs of barge shipments have a wide variation, owing to suspension of service due to winter conditions, low water in rivers, obstructions to navigation requiring dredging, etc. Where conditions are favorable, barge shipments can be made at low costs.

Advantages of Pipe Lines

The relation of pipe lines to other forms of transportation is illustrated in various ways in the principal areas affected by the new gasoline pipe lines of 1941. In looking over what is being done this year, it can be seen that pipe-line transportation is supplanting use of tankers and trucks in some areas, railroads in others, and barges and railroads in others.

The first gasoline system put in service this year was Shell Oil Co., Inc.'s 59-mile, 6-in. line from Fall River to Waltham, Mass., with a capacity of 10,000 bbl. daily. This line makes it possible to reduce the mileage of tankers which now dock at Fall River instead of Boston. Important economies are achieved by eliminating high costs due to trucking through congested traffic in the vicin-

ity of a metropolitan marine terminal.

Construction is starting on a 24-mile, 6-in. lateral from Shell's Fall River-Waltham trunk line which will branch off at Sherborn and extend to West Boylston, north of Worcester, Mass., where products will be transshipped for movement by land and water from a terminal located on Lake Wachusett.

In western New York State, Socony-Vacuum Oil Co., Inc., is preparing for construction of a 6-in. line from Syracuse to Binghamton via Ithaca. Work will get under way June 1. This line will be an extension of the 6-in. line laid from Buffalo to Syracuse which has displaced shipments by canal barges.

Greatest Pipe-Line Activity

The most active territory for pipe-line construction of any kind in the country is an area which includes Kansas, Nebraska, South Dakota, Missouri, and Iowa where work is getting under way this month on four pipe lines with terminals near the Missouri River Valley. All of the four lines are 6-in. and total 750 miles. Construction started early this month on Standard Oil Co. (Indiana) 106-mile line to Des Moines, Iowa, from a point on the company's Kansas City-Council Bluffs, Iowa, line near Burlington Junction, Mo. Standard of Indiana at the same time started a 168-mile line which will extend the system from Council Bluffs, Iowa, to Sioux Falls, S. D. Pipe for these lines has been delivered along the right-of-way since the middle of January. Pipe deliveries have been assured for the other two projects to Missouri River Valley points. Socony-Vacuum Oil Co., Inc., will start soon on a 250-mile line from the company's trunk line at Topeka, Kans., to Sioux City, Iowa. Globe Oil & Refining Co. will commence this month to lay 225 miles from the company's refinery at McPherson, Kans., to Council Bluffs, Iowa.

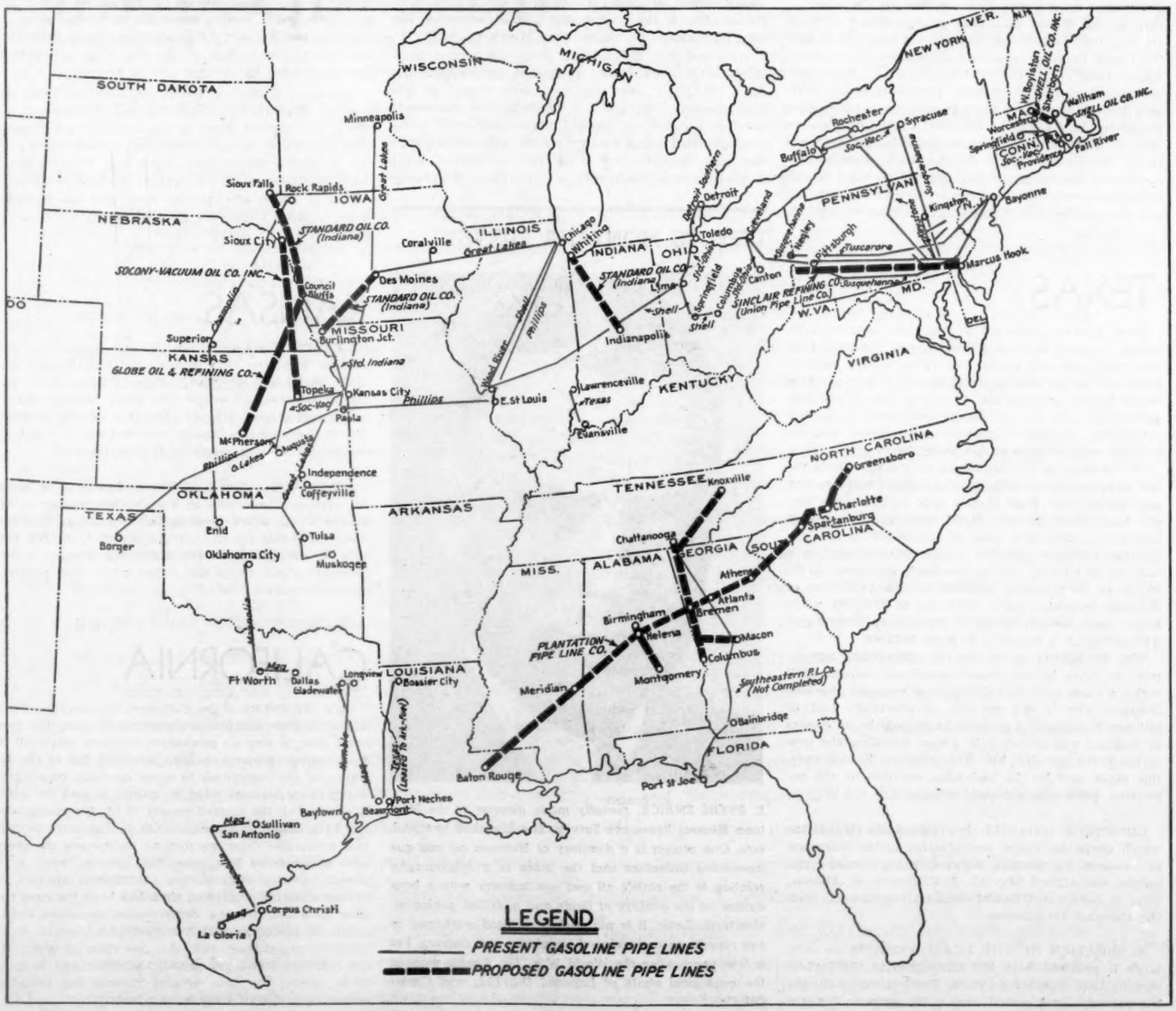
These lines are being built as the result of keen competition for business in the area in the last 2 years. Within a few months after Standard of Indiana completed the 8-in. line to Council Bluffs, Iowa, in 1939, Champlin Refining Co. extended its 6-in. line from Superior, Neb., to Rock Rapids, Iowa. At that time Socony-Vacuum started to make barge shipments to Omaha to compete with Standard; since then Socony-Vacuum has decided that transportation by pipe line along the Missouri River Valley is preferable to shipments by barge. The situation in this area has arisen from the fact that when one company enters a trade territory with a gasoline pipe line, other companies find it desirable to have pipe lines, also, in order to compete. The present pipe line boom in this area indicates a natural trend toward the most economical form of transportation under the conditions of free private enterprise which are customary for business in this country. In particular, it is another example of the tough competition between Standard of Indiana and Socony-Vacuum which has gone on for a number of years. In this valley area, Champlin and Globe also find they can meet the situation with their independent pipe-line facilities.

Whiting-Indianapolis Line

Similar situations exist in two other areas where important projects are planned. Standard of Indiana is preparing to lay a 147-mile, 8-in. line from Whiting, Ind., to Indianapolis to meet competition from Shell's Wood River, Ill.-Columbus, Ohio, pipe line which has an Indianapolis terminal. In Pennsylvania, Sinclair Refining Co. plans to lay a 340-mile line from Marcus Hook to the

(Continued on Page 203)

Map directing special attention to new gasoline pipe-line projects which are now being built or which are scheduled for early construction



STATE CAPITALS...

OKLAHOMA

HEARING HAS BEEN CALLED May 29 before the Corporation Commission to receive testimony on a protest filed by T. B. Hall, superintendent of the Osage Indian Agency, over the use of vacuum in the production of oil from the Burbank field in Osage and Kay counties, Oklahoma.

On May 22, the commission will hear testimony supporting or opposing institution of water-flood operations by Phillips and Milam in Bartlesville sand leases in Sections 3, 4, and 33-24-17, in Nowata and Rogers counties. J. F. Smith will present testimony before the commission May 23 supporting his application for inclusion of additional acreage in the Romulus field, Pottawatomie County.

Ten-acre spacing has been ordered by the commission in the Wilcox sand area on application of Shell Oil Co., Inc., in parts of Townships 14 and 15, Range 7e, Creek County, commonly designated as the East Stroud field.

Regulations for determining potentials of all wells and fields in the state's Class B pools for the 6 months beginning July 1 will be reviewed by the commission May 28. Regulations governing potentials of all wells in the Wilcox zone of the Oklahoma City field will be considered on the same day. Market demand for all Oklahoma crude, including requirements from prorated and nonprorated fields, also will be considered May 28.

TEXAS

NEW TAXES IMPOSED on the Texas petroleum industry by the omnibus tax bill total $10,990,617, it was estimated this week. The Texas old-age pension fund will get an additional $11,253,121 from new taxes levied by the omnibus bill. Of course, not all the new petroleum taxes go for old-age assistance, as teacher retirement, dependent children, needy blind, and the general revenue fund all get their share.

Of the total of $22,087,501 in new taxes which the bill is estimated to raise, the petroleum industry will pay almost half. Most of this falls on producers who are expected to pay $8,536,000 more in gross-production taxes alone, or a total of $23,536,000 in this one tax. Gas producers are due to pay $700,000 more, or a total of $1,400,000, and carbon-black producers $179,617 more, or a total of $600,000. Petroleum's share of the new franchise tax is estimated at $750,000, while a new gross-receipts tax of 2.2 per cent on oil and gas-well servicing is expected to raise $825,000.

The $10,990,617 added to the $39,419,222 already paid in taxes by the Texas petroleum industry will make a state total of $50,409,839 a year for this one industry. This is 48.8 per cent, or practically half, of all state business and property taxes paid by all classes of business and property in Texas, including the new levies of the omnibus bill. This does not include gasoline taxes paid by the individual motorist on the petroleum industry's principal product.

GOVERNOR O'DANIEL has signed the legislation which continues Texas' participation in the interstate oil compact for another 2 years. The governor's signature was affixed May 15. J. C. Hunter of Abilene, Tex., is Governor O'Daniel's official representative on the Compact Commission.

ALTERATION OF THE LEASE PERIODS on state lands is provided in a bill introduced in the legislature by Rep. Augusting Celaya. The bill would change the primary lease period now at 25 years to 5 years and further provides the lease would be in force "as long after 5 years as oil, gas, or other minerals covered by the lease is being produced."

The land commissioner would be authorized with consent of the owner to revise any lease heretofore made, even before creation of the school land board, to conform to the bill.

It has been argued that operators, particularly in the Gulf Coast submerged leases, under the present proration restrictions are not able to recover as much on their drilling investments under the 25-year period.

THE RAILROAD COMMISSION reported estimated oil production on Saturday was 5,546 bbl. below the Bureau of Mines estimated market-demand figure of 1,382,000 bbl. daily. State-wide daily allowables on that date were 1,426,584 bbl., 4,677 bbl. higher than on the preceding Saturday, but underproduction of allowables was expected to hold production below the bureau's figure. This is the nearest that Texas' production has been to the demand figure since March 1.

West and Gulf Coast Texas made the largest gains in allowables. A 1,038-bbl. gain went to the Gulf Coast for a 261,166-bbl. allowable total. West Texas' 242,755-bbl. allowable figure was 1,639 bbl. over last week. Southwest Texas was 696 bbl. higher with its 231,388-bbl. allowable. East Central Texas, gaining 568 bbl., had total allowables of 81,790 bbl. A 437-bbl. boost came to North Texas with a 114,614-bbl. total daily allowable. The Panhandle picked up 180 bbl. daily for a 77,838-bbl. total. West Central Texas with 47,970 bbl. had gained 141 bbl. The East Texas field allowable remained at 369,063 bbl.

THE HOUR-LONG STATE-WIDE proration hearing held in Austin on Monday failed to support full expectations of extensive requests for more production. Commissioner Sadler saw in the limited number of requests for additional production a picture of firmness in the oil market. He branded the small turnout of oil men and representatives as a reflection of this firmness.

The most optimistic picture of future demand was presented by Paul McDermott of Sinclair Prairie Oil Co., who suggested that the entire state allowable be increased in order for the state to obtain more of the growing market. He specifically asked that those fields throughout the state where Sinclair has connections be increased. This request was made strongest for North Texas, where Sinclair has production and has continually pressed for higher allowables. Mr. McDermott explained that his company had worked out a program to move North Texas oil northward to Chicago by pipe line and would use more oil. He directly asked that the take from the K.M.A. field be hiked from 7,500 bbl. daily to 15,000 bbl. daily.

Phillips Petroleum Co., through E. H. Foster, asked again for more oil in the Panhandle. The spokesman declared that storage in the Panhandle had decreased 355,890 bbl. since January 1 and at present stood at 1,646,789 bbl. Danciger Oil & Refineries asked for Panhandle oil to supply needs for its Pampa plant. It was pointed out that Texas Co. was taking back connections to the amount of 771 bbl. daily which Danciger has held.

Marion S. Church of Dallas, representing Talco Asphalt & Refining Co., entered a plea for more of the Talco field asphalt crude to fill government contracts. He was joined in the request by representatives of W. B. Hinton and others. Talco and Sulphur Bluff, both in Northeast Texas, operate without shutdowns, and L. L. Travis of Longview asked that the Hawkins field in Wood County be treated similarly because it also produces an asphalt crude.

DIRECTS MONTANA SURVEY . . .

E. BYERS EMRICK, recently made director of the Montana Mineral Resources Survey, has launched two projects. One project is a directory of Montana oil and gas associated industries and the other is a bibliography relating to the state's oil and gas industry with a brief outline on the geology of fields and undrilled geological structures. Later, it is planned to do field work and issue reports on undeveloped structures and districts. For a few years after the World War, Mr. Emrick was on the geological staffs of Imperial Oil, Ltd., and Carter Oil Co.

KANSAS

HEARINGS TO DETERMINE the market demand for gas from the Otis, Lyons, and Cunningham gas fields in Kansas for the months of June, July, and August will be held in the Allis Hotel, Wichita, Kans., starting at 2 p.m., May 27. The Otis field is in Rush and Barton counties, Lyons in Rice County, and Cunningham in Kingman and Pratt counties.

ALLOWABLE PRODUCTION for June will be based on testimony presented at a statewide hearing called by the Corporation Commission May 27 at Wichita, Kans. Allowable for the current month is 217,900 bbl. daily, a new peak for the state, but demand is expected to climb above this figure when June nominations are totaled.

CALIFORNIA

NEW MEMBERS of the California Conservation Committee held an organization meeting May 22. The proposed plan to step up production of heavy crude oil to meet current demand remains unsolved due to the inability of the committee to agree on what constitutes heavy crude oil and what measures to take in order to accomplish the desired results. With few exceptions the 1941 conservation committee is the same as the 1940 group and therefore they all understand the problems encountered last year. This should result in a smooth running organization. Curtailment appears to be less effective at present than has been the case for some time and the new conservation committee chairman will probably start a movement to secure more effective compliance with the proration program. If the committee can get production down and keep it down during the next several months the industry should be in good shape next winter.

The OIL AND GAS JOURNAL

PRODUCING REFINING NATURAL GASOLINE PIPE LINE

Published weekly by The Petroleum Publishing Company at Tulsa, Oklahoma

The Matter of Priorities

Operators did a good job telling legislative, administrative and military investigators about the oil business' ability to produce—so conclusive in fact that these groups now agree that the industry is prepared to do its part, come what will.

But it now appears that the industry's representatives will have to go back and explain not only what they are doing but how they are doing it. Recent developments in the matter of priorities indicate that Washington has no clear conception of what it takes in equipment and materials to maintain present oil operations. Both quality and quantity of supplies are involved.

Priority rulings have been made effective which if continued will seriously restrict many petroleum operations. The industry has expanded and is now ready because the tools and supplies with which it works have steadily been improved. Petroleum products are cheap and plentiful because of them.

These facilities explain why producers complete a well in this country every 18 minutes and are able to drill 50 miles of hole daily in the search for crude oil. They enable refiners to process completely 2,500 bbl. of crude oil every minute of the night and day and to refine a tank car of gasoline every 9 seconds. They also explain the pipe liners' ability to force 600,000 tons daily of crude oil and products through a vast transportation network.

Summarized, the industry at this time has the combination task of getting oil from 390,000 completed wells; drilling 30,000 new ones yearly; operating 460 refineries and 650 natural-gasoline plants 24 hours daily and keeping 126,000 miles of pipe line at work. Then there are the tens of thousands of wholesale and retail service stations.

These are the main features. There are hundreds of supplementary operations, many of which in other industries would be considered major enterprises. All operations of the petroleum business add up yearly to many millions of tons of essential equipment and supplies.

The uninformed at Washington apparently are of the opinion that the industry not only can get along with less but they also feel that quality of materials is not important as in many other industries. No assumption which has to do with this country's defense could be more gravely erroneous.

You can't drill oil wells up to 15,000 ft. with the metals of a decade or two ago. The modern refinery with its high pressures and temperatures, its use of chemicals and its hundreds of mechanical contrivances, draws on as wide a variety of alloys as does a complete armament plant. No industry relies more on control instruments and many other operating aids, made available by scientists, inventors and manufacturers.

This industry cannot go back to the materials and practices of a few years ago any more than this war can be fought successfully with the implements of the 1914-1918 conflict.

It takes many metals and numerous other specially designed and manufactured products to build the modern fighting plane. The same condition applies to the production of crude oil and refinery operations which make possible the 100-octane gasoline and specially processed oils with which the plane is fueled and lubricated.

The situation cannot be handled with a few arbitrary priority rulings. Priorities must be based on an accurate knowledge of the requirements of many industries. This is no place for the makeshift or the trial balloon. Those responsible for the allocations should be able to look down the road a long way.

If general industry which serves both the civilian and soldier is paralyzed because it does not have the required materials, then this country has been weakened at its most vital point no matter how capacious its arsenal may have become.

Purchasers Raise Oil Prices in Six States

ADVANCES of 10 cents per barrel on crude oil purchased in the Mid-Continent and 9 to 15 cents in Texas, New Mexico and Louisiana were made Monday and Tuesday by Shell Oil Co., Inc. Several purchasers met the advances in Oklahoma and Kansas, including Continental Oil Co., Sinclair Prairie Oil Marketing Co., Phillips Petroleum Co., Carter Oil Co. in Oklahoma alone, Skelly Oil Co. and others.

Prices in the Texas Panhandle were advanced 9 cents per barrel by Phillips and Sinclair Prairie.

The maximum advance in Shell's new coastal schedule of 15 cents applies to certain gravity crudes in coastal Louisiana. In the Iowa district, which has been combined with Black Bayou and White Castle, the new schedule starts at 99 cents for oil below 20° gravity and extends upward at stages of 2 cents to a top price of $1.29 for 34° gravity and above. Previously, price schedules there were on the basis of both 2 and 3-cent differential. The increase under the new posting ranges from 10 to 15 cents per barrel.

The Benton field in Illinois, the only area in that state where Shell is a purchaser, received a 10-cent advance, making the new price there $1.37 per barrel.

The last general price advance for the southwestern producing states was posted at the end of March and start of April. Since that time, Illinois producers received another advance of 10 cents April 28.

Advances in Oklahoma, Kansas and the Texas Panhandle were made effective at 7 a.m., May 19, while those in other portions of Texas, New Mexico and Louisiana posted by Shell were made May 20.

Upton, Crane, Ector, Howard, Glasscock, Winkler and Yoakum counties, Texas, and Lea County, New Mexico, were posted by Shell at 70 cents per barrel for crude below 20° gravity. A differential of 2 cents applies to a top price of $1.04 for 36° gravity and above. Pecos County (Yates field regular) crude was posted at flat 95 cents and shallow production there at 82 cents.

Shell's schedule in Fisher County, Texas, starts at 86 cents for oil below 25° gravity and ranges upward at stages of 2 cents to $1.18 for 40° gravity and above.

East Texas, Livingston, Polk County, Texas, were posted at flat price of $1.25 per barrel.

Roanoke and Chalkley field crudes were posted by Shell at 94 cents for below 20° gravity and $1.24 for 40° gravity and above, an advance of 8 to 15 cents.

Gibson, South Houma, West Lake Verret and Hester crudes below 20° gravity are posted by Shell at 89 cents. A differential of 2 cents applies to $1.19 for 34° gravity and above.

Happytown crude is quoted at a flat price of $1.15 per barrel.

Prices posted by those meeting the advance in the Texas Panhandle range from 79 cents per barrel for crude below 25° gravity to $1.11 for 40° gravity and above.

The Oklahoma-Kansas schedule of Sinclair Prairie starts at 95 cents for 25-25.9° gravity oil and ranges upward at a differential of 2 cents to a top price of $1.25 for 40° gravity and above. Continental's Oklahoma and Kansas schedule varies to the extent that it starts at $1.01 for 28-28.9° gravity oil and ranges up to the top price of $1.25.

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Plan Preliminary Arrangements For 1942 Petroleum Exposition

PRELIMINARY arrangements for the twelfth International Petroleum Exposition and Congress, to be held in Tulsa, May 16-23, 1942, were outlined at the annual luncheon meeting of the board of directors at the Tulsa Club on Tuesday of this week. Officers of the board were reelected for another year and William B. Way, general manager, reported in his annual statement that 59.8 per cent of the available space for the 1942 show had already been reserved.

Mr. Way reported that the exposition had made $175,000 worth of permanent improvements to the exposition grounds in the past 3 years and that no bills were outstanding. He also reported that sufficient funds were on hand to launch next year's show.

"The 1940 International Petroleum Exposition was, by far, the largest and best of the 11 shows held since 1923," he said. "We had a total of 782 exhibitors, we had a total of 254,916 paid admissions and we increased the attendance of international buyers threefold over any previous show."

As for the 1942 show, Mr. Way said that 271 reservations for exhibitors' space had already been made and that requests from 27 entirely new exhibitors had been received. He also said three of the main committees were at work—the international delegates committee, headed by W. G. Green of the Engineering Laboratories, Tulsa; the Hall of Science committee, headed by Dr. Gustav Egloff, director of research for Universal Oil Products Co., Chicago, and B. B. Weatherby, of the Amerada Petroleum Corp., Tulsa, and the safety committee, headed by Henry Boggess, director of safety for the Sinclair companies.

The international delegates committee was to meet with the four chapters of the Nomads Clubs in Tulsa during the week.

Officers reelected at the board meeting were W. G. Skelly, president of the Skelly Oil Co., Tulsa, president; Mr. Way, general manager; C. H. Pape, secretary-treasurer of the Selby Oil & Gas Co., Tulsa, treasurer; Alf Heggem, president of the Oil Well Improvements Co., Tulsa, and Frank J. Hinderliter, president of the Hinderliter Tool Co., Tulsa, vice presidents, and Frank O. Prior, president of the Stanolind Oil & Gas Co., Tulsa, and W. M. Bovaird, president of the Bovaird Supply Co., Tulsa, members of the executive committee. H. R. Powers was reelected secretary.

William G. Skelly, president, Skelly Oil Co., Tulsa, reelected president, International Petroleum Exposition

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Illinois Conservation Proponents Support Bill

SPRINGFIELD, Ill., May 20.—Supporters of an oil-conservation bill, designed to prevent physical waste in Illinois, were heard for the first time May 21 at a public hearing in the state senate chamber.

More than 100 qualified witnesses, representing landowners, operators, and royalty owners testified at the hearing.

Former Gov. John Stelle, in his first public appearance since retirement from office in January, led opposition to the measure at an initial hearing of the senate gas and oil committee on May 14.

Other opponents who appeared against the measure included Dorsey Hager, Centralia geologist, and Charles Vurcell, Salem newspaper publisher.

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Pennsylvania Crude-Oil Price Advanced 15 Cents

OIL CITY, Pa., May 20.—South Penn Oil Co., one of the large purchasers in eastern fields, announced today that it will advance the posted price for Pennsylvania crude oil 15 cents per barrel effective May 21.

The increase will lift Bradford crude to $2.55 per barrel, Southwest Pennsylvania $2.20, and Eureka $2.14 per barrel.

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Sinclair-Wyoming Oil Co. Raises Crude Price 10 Cents

Sinclair-Wyoming Oil Co. advanced crude 10 cents per barrel in all Wyoming fields in which the company purchases, effective 7 a.m. May 20. The company purchases in Salt Creek, Lost Soldier, Wertz, Mahoney dome and East Mahoney.

THE MARKETS*

CRUDE OIL: Advances of 10 cents per barrel on Mid-Continent crude oil this week confirmed previous evidence of strength in this market. Texas Panhandle producers received an increase of 9 cents; Oklahoma and Kansas, 10 cents and parts of Illinois, 10 cents. Concentration of crude demand in the Mid-Continent to minimize results of the transportation deficiencies along the eastern seaboard promises sustained buying pressure on the inland crude market.

REFINERY PRODUCTS: Mid-Continent refiners have advanced tank-car quotations ⅛ cent per gallon on all grades of motor fuel and have increased lubricating-oil prices from 0.5 to 1 cent per gallon. Gulf Coast refiners are maintaining product prices at previous levels despite a lull in business created by transportation shortages. Wax and gasoline prices have been advanced in Pennsylvania. Pacific Coast refiners are stiffening residual fuel-oil prices but gasoline is moving in routine fashion without particular feature.

TANK-WAGON AND POSTED DEALER: Fuel-oil contracts in the eastern section of the country for the winter of 1941-42 are being written without specifying a maximum price. Downward adjustments were forced in dealer and tank-wagon prices in local areas of the middle western marketing territory in Iowa and Missouri. Fuel oil tank-wagon prices were advanced in North Carolina, Maryland, South Carolina and the District of Columbia 0.2 to 0.3 cent per gallon.

FINANCIAL: Oil securities were unable to sustain the full scope of gains in the preceding week and declined fractionally. Average of 30 representative stocks for the week ended May 17: High, 25.09; low, 24.18; close, 24.53. Week ended May 10: High, 25.22; low, 23.82; close 24.84.

*Detailed information in Market Section.

ANNOUNCING

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CALIFORNIA: BAKERSFIELD, LOS ANGELES

Cole Introduces Bill To Facilitate New Pipe Lines

WASHINGTON, D. C., May 20.—Legislation designed to facilitate the construction of pipe lines to the East Coast was introduced in the House today by Rep. William P. Cole, Jr., of Maryland, chairman of the special petroleum subcommittee of the House interstate and foreign-commerce committee, as President Roosevelt urged enactment of the proposed measure.

In a letter addressed to House majority leader, Sam Rayburn of Texas, the president requested "early and earnest consideration" of the measure by Congress.

"As a result of recent study by the special committee on petroleum of the House committee on interstate and foreign commerce," Mr. Roosevelt wrote, "Chairman Cole has transmitted to me for consideration a proposed measure 'to facilitate the construction, extension or completion of interstate petroleum pipe lines related to the national defense.' This measure is concerned with one of the vital phases of our national-defense program. The vast concentration of industry, population and military bases on the Atlantic Coast is now dependent for petroleum upon tankers plying between the Gulf Coast and the Middle Atlantic ports. Not only is this water route long and potentially perilous, but even present demands upon these transportation facilities make restrictions of oil consumption to essential uses a distinct possibility within a few months. The immediate construction of pipe lines to augment the supply to the Atlantic Coast is the one means available to relieve the situation.

"The bill which is proposed by Mr. Cole seems to be adequate to accomplish its objectives, and, in my opinion, it is a measure of first rank in importance. The situation which the bill is designed to correct must be remedied. I therefore take this means to call the measure directly to your attention and to urge that it be given early and earnest consideration."

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Suman Traces Industry's Part in Defense Program

John R. Suman, vice president of the Humble Oil & Refining Co., Houston, Tex., and president of the American Institute of Mining and Metallurgical Engineers, presented a word-picture of the oil industry's

P. E. Fitzgerald tells John Suman the A.I.M.E. is ready to hear the latter's report "Oil and Defense." Mr. Fitzgerald is president of the Tulsa chapter and Mr. Suman is national president

"all-out-aid" program as he spoke before the Tulsa chapter of the Institute May 19. "Capacity of the industry to produce crude oil is far in excess of what it is likely to be called upon to supply," he said, "and while the refining branch is credited with manufacturing capacity to sustain all our normal and preparedness needs, there is developing a serious shortage of transportation facilities to carry crude and refined products from the Gulf Coast to eastern markets."

He said he believed some special consideration should be given by our government to deferring the drafting of college students taking engineering work if industries generally are going to be required to produce all the products needed for modern war. He asked also that some relief be granted the oil industry from investigation by the federal Government while the former is being asked to produce more oil, make better products, and distribute them under abnormal conditions.

"Statisticians tell us," he said in conclusion, "that in 9 months of intensive defense efforts this country has made more progress, with free men working under a system of private enterprise, than the much-vaunted Nazi economy achieved in 2½ years. Our traditional methods of free private enterprise when applied to the oil industry have brought about a vast increase in the known reserves of oil, continuous improvements in the methods of producing and refining oil, better quality of products, and constantly lower costs to the consumer. We should not risk these advantages in order to experiment with new systems."

DEATHS

HERMAN F. KLAMPT, 64, died last week at a hospital in Muskogee, Okla. Pallbearers at the funeral were all fellow employes of Stanolind Oil & Gas Co.

ROLEY C. McCARTER, 49, oil operator with holdings in Texas, Oklahoma and New Mexico, died at San Diego, Calif., May 14. He maintained homes in San Diego and Cisco, Tex.

JEREMIAH LOVEALL, assistant East Texas district superintendent for Arkansas Fuel Oil Co., died at his home in Longview, Tex., May 15. He had been associated with the company for 21 years, and was active in Masonic work.

HIRAM O. BIRD, one of the owners of the L. F. Smith Oil Field Machinery Co., died in a Tulsa hospital May 18. Mr. Bird was born in Flint, Mich., went to Oklahoma City in 1917, and came to Tulsa 3 years later. His widow survives.

SAMUEL R. ROSEBERG, 72, who had been active in the southland oil industry for the past 40 years, died last week at his home in Los Angeles, Calif., following a heart attack. He was chairman of the Golden Bear Oil Co., and was one of the founders of the Kellogg Oil Co., which later became the Richfield Oil Co. Mr. Roseberg, who had lived in Los Angeles since 1892, leaves his wife and a daughter.

CHARLES ARTHUR LESTER, 47, Dallas, Tex., independent oil producer, died May 15 at a Dallas hospital after a prolonged illness. Mr. Lester had been an active operator in Texas since 1925. His first connection with the oil business was in 1913 at Bartlesville, Okla. Afterward he was, for a number of years, with Marland Oil & Refining Co., and in 1933 became a partner in Lester & Duffield, Inc. He was secretary of the Dallas Petroleum Club, and a director and member of the executive committee of the Independent Petroleum Association of America. His wife and a daughter survive.

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Consumers' Antitrust Oil Suit Is Dismissed

CHICAGO, May 19—The first consumers case brought by 13 Chicago plaintiffs seeking treble damages from several major oil companies involved in the now 3-year-old antitrust suits at Madison, Wis., was dismissed in the U. S. District Court here this morning by Judge John P. Barnes "upon motion of the plaintiffs. The court directed that all costs incurred by each dismissing plaintiff shall be taxed to such plaintiff."

This dismissal came in a consolidated cause, made up of actions brought by P. D. Carroll Trucking Co. and nine other trucking companies as plaintiffs against Shell Oil Co., Inc., et al as defendants, and Atlantic Brewing Co., and two other plaintiffs against Shell et al as defendants. The consolidated case had been set for trial on June 2 before Judge Barnes.

Defendant companies named in the action were: Socony-Vacuum Oil Co., Inc., Shell Oil Co., Inc., Wadhams Oil Co., Cities Service Oil Co., Continental Oil Co., Pure Oil Co., Sinclair Refining Co., Mid-Continent Petroleum Corp., Phillips Petroleum Co., Skelly Oil Co., and Globe Oil & Refining Co.

Continental Injunction Threatens Texas Oil Curb

AUSTIN, Tex., May 19.—A permanent injunction against the current proration order of the Railroad Commission as it applies to Continental Oil Co.'s operations in the Conoco-Driscoll field, Duval County, has posed a new problem for Texas regulatory authorities.

Continental was granted an injunction by District Judge Roy C. Archer authorizing the company to produce amounts specified in the January 1941 proration order from the Conoco-Driscoll properties.

Jerry Sadler, railroad commissioner, referred to the injunction as "the most serious problem since the advent of proration."

"If that decision is upheld," he said before the meeting here May 19 of Texas producers attending the statewide proration hearing, "it means proration has failed."

Continental appealed for its injunction against the commission's proration orders based on the new formula which considers characteristics of the crude oil as related to demand in establishing allowables.

Mexican Oil-Industry Deficit Now 150,000,000 Pesos

Deficit of the Mexican petroleum industry since expropriation of private oil company properties in March 1938 has increased until it is now estimated at 150,000,000 pesos. The peso is now worth about 4.85 cents.

Petroleos Mexicanos, the official oil company under whose management the expropriated properties were placed, nor the Ministry of Finance have made any definite statement regarding the financial condition of the government's conduct of the oil industry in recent months.

There has been no official statement except on petroleum and products exports in 1940, announcement by Petroleos Mexicanos that these sales last year yielded about $16,000,000 (American). Estimates in private quarters are that these exports last year were around 20,550,000 bbl., as compared with the upward of 25,000,000 bbl. a year that were being shipped just before expropriation. Private sources approximate the 1940 exports as follows, in barrels:

United States, 15,700,000—4,150,000 refined and 11,550,000 crude; Italy, 2,950,000—700,000 refined, 2,250 crude; bunker, 550,000 (all refined); Japan, 760,000 (all crude); Cuba, 130,000 (all refined); Scandinavia, 100,000 (all refined); Australia, 90,000 (all refined); Chile and Portugal, 80,000 each (all refined); Uruguay, 70,000 (all refined), and miscellaneous, 40,000 (all refined).

Private quarters give Petroleos Mexicanos credit for producing more oil last year than it announced. The company reported 1940 production at 41,876,000 bbl. Private sources figure the output was around 44,000,000 bbl.

C-B ENGINES are "ACES" for CONTINUITY OF SERVICE IN OIL PIPE-LINE PUMPING

LAWRENCEVILLE, ILL. — Texas Empire oil pipe-line pumping station contains two Cooper-Bessemer Type GN six-cylinder gas engines, which drive centrifugal oil pumps through speed increasers. These gas engines are built with true Diesel sturdiness in every piece and part, and are convertible to oil fuel.

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529 M & M Building, Houston, Texas
1501 Arcade Building, St. Louis, Missouri

Plan 300,000-Bbl. Crude Line, Texas to Eastern Points

(Continued from Page 40)

falo the oil moves via New York Barge Canal to the Hudson River and down that artery to Long Island.

Another factor which would favor construction of a crude line from East Texas is that of economics, a consideration of great importance if the industry is to succeed in keeping prices from reaching too-high levels. The tariff on crude oil transported from East Texas to the East Coast by way of the rather complicated system now in use is 67½ cents per barrel, a figure which could probably be halved by a single line with greater volume. This tariff, incidentally, is reported to be so close to actual cost that virtually no margin for contingencies remains. Tariffs on the proposed line would also be less than the present cost of delivering East Texas crude to the Gulf by pipe line and thence by tanker to the East Coast, which now ranges from 62½ to 69½ cents depending on the gravity. Even in normal times, assuming an average tanker rate of 25 cents per barrel plus the East Texas-Gulf Coast pipe-line rate of 12 cents, economics of the pipe-line movement would be comparable if, as indicated, it would be possible to halve the present tariff.

Additional economic factors which would have an effect on prices and therefore cannot be ignored are the cost of a trans-Ohio line, which probably would be in a range of $5,000,000 to $10,000,000, and, of far greater importance, that the use of Pennsylvania lines would necessitate the westward movement of products by the far more expensive tank-car or tank-truck methods.

The same factors would apply to a products line with the exception that a larger quantity of oil could be transported through the latter. It is roughly estimated that 40 per cent more gasoline and 30 per cent more heating oil than crude oil could be transported through lines of equal size and pumping equipment. In addition cold weather would not seriously affect volume of delivery in winter.

Committee to Study Problem

The matter of the Texas-East Coast line is expected to share importance with the possibility of further tanker diversion at the first meeting of the American Petroleum Institute's new fact-finding committee in New York May 23. The committee, appointed by W. R. Boyd, Jr., executive vice president of the Institute, has been asked by the Office of Production Management to make a prompt inventory of all available transportation facilities to the East Coast, the extent to which they are now being used and what can be done to increase the facilities and their use. It is expected that by laying a full picture of the situation before the industry, individual companies will be encouraged to take prompt action to help meet it and avert a possible shortage of supplies. The committee has also been asked to explore with representatives of O.P.M. the question of whether this situation requires cooperative action by the industry so that O.P.M. may determine whether or not a formal petroleum industry committee should be formed.

The 22-man committee is composed of 12 oil-company presidents and 10 oil-association representatives. Its members are John A. Brown, Socony-Vacuum Oil Co., Inc.; Robert H. Colley, Atlantic Refining Co.; H. D. Collier, Standard Oil Co. of California; W. S. Farish, Standard Oil Co. of New Jersey; W. A. Jones, Cities Service Oil Co.; J. Frank Drake, Gulf Oil Corp.; J. Howard Pew, Sun Oil Co.; Frank Phillips, Phillips Petroleum Co.; W. S. S. Rodgers, Texas Co.; Reese H. Taylor, Union Oil Co. of California; R. G. van der Woude, Shell Union Oil Corp.; E. G. Seubert, Standard Oil Co. of Indiana.

Frank Buttram, Independent Petroleum Association of America; J. C. Hunter, Mid-Continent Oil and Gas Association; N. H. Weber, National Petroleum Association; C. L. Henderson, Western Petroleum Refiners Association; George Reid, Gulf Coast Refiners Association; Roy Collum, California Oil and Gas Association; Lawrence van der Leck, Oil Producers Agency of California; Parker L. Melvin, Pennsylvania Grade Crude Oil Association; Ray Miller, Natural Gasoline Association of America, and Charles P. McGaha, National Stripper Well Association.

Will Entail Expensive Adjustments

As the industry moves to meet this problem, two things are readily apparent. Its solution will necessitate a virtually nation-wide readjustment in the industry and this readjustment will in all probability be extremely expensive. It will not be limited to transportation facilities but all divisions of the industry, including marketing, refining and producing, will be affected to some degree.

Immediately affected transportation facilities were, of course, the first to feel the effects of the tanker diversion. The direction of movement in some lines has been changed, inactive capacity will be utilized wherever possible, new lines are projected and the character of products in some lines may be changed. The railroads' petroleum transportation facilities which, due to high cost, have languished in recent years so that now there are fewer tank cars in service than there were 5 years ago, will be studied. There were 147,919 tank cars in petroleum service as of January 1, 1940, 90 per cent of which are privately owned, against 157,105 on January 1, 1935. In addition, there are 18,629 tank cars in other than petroleum service and it may be possible to utilize part of these. Already heavy and prospectively heavier railroad traffic, however, would probably defeat any attempt to make any substantial increase in rail petroleum transportation, particularly in the case of long hauls.

Inland-water transportation, including the Great Lakes, accounted for less than 10 per cent of all water-borne petroleum transportation in 1939, the last year for which data are available, so that this means of transportation may be increased greatly. It is pointed out that it would be possible to transport refined products up the Ohio to Pittsburgh whence they could be shipped to the seaboard through three existing lines and another which is planned. Existing lines are those of Susquehanna, Tuscarora and Keystone. Sinclair Refining Co. is prepared to construct a 6-in. line to Marcus Hook from Pittsburgh. Another means of water transportation that could possibly be expanded is that by way of the Great Lakes through the New York Barge Canal to large consuming centers along the Hudson River valley. Use of inland waterways, however, would be limited to the availability of power units which will be required for the transportation of other products as well as oil.

One possible effect on marketing is that divisions now supplying the Midwest will extend their territories eastward. This will affect companies with refineries in the Midwest. These refineries in the week ended May 14 ran 628,000 bbl. per day to stills, an increase from the previous week but still only 85 per cent of rated capacity. With inactive crude-oil-pipe-line capacity from the Mid-Continent it would be easily possible for these refineries to increase their runs.

Another possible marketing effect may strike the important Gulf Coast district. The East Coast is the principal destination of products produced in this district so that a restriction on transportation facilities would result in a corresponding restriction on Gulf Coast sales. This loss would be offset to some extent if tankers are used to transport refined products in preference to crude oil, however.

Refining will be affected in those areas which are affected by the changed conditions. East and Gulf Coast refineries may find it necessary to alter runs and those in the Midwest will undoubtedly be called upon to accelerate their pace of operations. Changes in yields may also be required to provide adequate supplies of essential products. Last summer East Coast refineries produced record yields of heating oil to meet a record demand and this year may be forced to take even deeper cuts in the gas oil, distillate fuel-oil range.

This may be done at the expense of gasoline, stocks of which will probably be drawn on to a greater extent than ever before. East Coast stocks of motor fuel aggregate 20,000,000 bbl., a total which could be reduced substantially before minimum working levels are reached.

Production will benefit in those areas which are called upon to supply the new movements and suffer in those from which it was formerly moved by tanker. These areas will be determined as changes in movement are made. Crude oil stored in the Cygnet, Ohio, area is now being purchased by Imperial Oil, Ltd., to replace the 10,000 bbl. of Venezuela crude which formerly was moved to Sarnia from Marcus Hook via pipe line.

Portland-to-Montreal Line

Standard Oil Co. of New Jersey confirmed this week earlier reports that it would build a 12-in. crude-oil line from Portland, Me., to Montreal, Canada. The line will have normal capacity of 50,000 bbl. daily. Maximum deliveries may be 60,000 bbl. daily in summer months. (See The Oil and Gas Journal, April 17 and May 15.)

Crude from the Gulf Coast and South American countries will be delivered by tanker to marine terminal at Portland and from there the pipe line will make delivery to Montreal.

The line is designed primarily to insure crude delivery to Canada in view of the growing shortage of tankers. The combination ocean and pipe-line delivery system will have about a third of the normal tanker voyage from the Gulf to Montreal. Another saving will be effected by ability to make deliveries throughout the year. Long-haul tankers are unable to make deliveries through the St. Lawrence in certain winter months.

The company announced that it is proceeding with aerial surveys and procurement of rights-of-way. Pipe has been ordered from Youngstown Sheet & Tube and Spang Chalfant companies for the Montreal line.

The West Coast will not escape the effects of the tanker diversion for it has been called upon to supply a proportionate share of the allocation to Britain. Coastwise tanker transportation of prod-

OIL and GAS JOURNAL EDITION

BAASH ROSS News

BAASH-ROSS TOOL COMPANY • LOS ANGELES • HOUSTON • NEW YORK

A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

HOW CORRECT ENGINEERING INCREASES THE EFFICIENCY OF PIPE CUTTING

Design of tool is important thing to look for when selecting casing cutters

Operators have often remarked about the unusually smooth, fast, cutting efficiency of the Baash-Ross Internal Casing Cutter and have asked whether there is any particular reason for this. There is—and this brings up an important angle on pipe cutters that you may not have thought about...

If you've spent much time around a machine shop, you no doubt have noticed that there's an important relationship between the *position* of the cutting tool and *point of support* of the "work." On a lathe, for example, when the cutting tool is close to the chuck, the cutting action is generally smoother, more efficient. As the tool moves farther away from the chuck, the danger of chatter and uneven cutting increases, particularly if the distance between chuck and spindle is great.

And when cutting pipe in your well, exactly this same thing holds true. The *shorter* the distance between the support and the cutting tool, the *better* the cutting action.

Now take a look at the Baash-Ross Internal Casing Cutter. Notice how close the cutting knives are to the anchoring slips? Only the thickness of a compact swivel connection separates them. *Now compare this close-coupled arrangement with any other internal cutter.* You'll find that where the Baash-Ross knives and slips are separated by only a few inches, in many cutters the knives and slips are separated by as much as several *feet.*

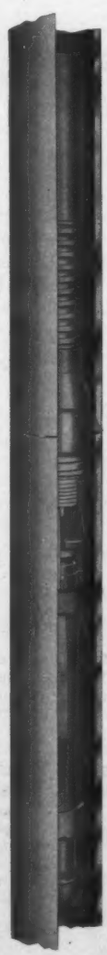
Naturally, this unusually close coupling of the knives and the slips means more rigid support while the cut is being made ...smoother, faster cutting action...and better all-around operating efficiency. This is one reason why so many operators prefer this tool for inside cutting work.

And here's another point that is important. Notice the square coil spring on the upper part of the body? When you apply the weight of the string downward to feed the knives against the pipe, the weight is applied to the knives *through* this spring. This cushions out any vibration or roughness that may occur in the drill string as it rotates, maintaining a constant, even feed at all times. Yet the feed can be instantly increased or decreased at the will of the operator to meet any changing requirements in the job.

Contrast this "cushioned" feed with the rough jarring feed that is apt to occur where the bare weight is applied directly to the knives...and you have another very important reason why the Baash-Ross Internal Cutter does such a top notch job of cutting ALL sizes and types of casing, tubing or drill pipe.

Still another thing that's worth remembering. With this cutter you can make *any* number of cuts on one run. This is a time and money-saver when you aren't sure just where the pipe is stuck. You can start low, make a cut—and if this doesn't free you—move up the pipe in stages, trying again and again until the pipe is freed.

There are a lot more advantages built into Baash-Ross Internal Casing Cutters



AN IMPORTANT FACTOR in the smooth cutting efficiency of the Baash-Ross Internal Casing Cutter is the close spacing of the cutter knives to the point of support.

CUTTING IS DONE HERE

TOOL IS SUPPORTED HERE

The accompanying article explains how this important engineering feature improves cutting efficiency...reduces "wobble" and chatter...saves time in making cuts.

but the best way to find out what they will do for you is to try one out on your own well. So make it a point to give Baash-Ross a jingle next time an inside cutting job comes along...and you'll do the job better, quicker!

(Leased in U.S.A.—Sold for export only)

COMPARED WITH MOST OIL TOOLS, a fishing tap appears to be about as simple a tool as you could find anywhere.

But even a fishing tap has its complications!

It must be *tougher* than a blue plate steak so that it will withstand twisting and bending and jarring without breaking off. Yet it must also be *hard* so that the threads will easily cut their way into whatever type of steel is "up" on the fish.

Now when you start combining *toughness* and *hardness* in the *same* piece of steel, you've got yourself a job that calls for a lot of experience to produce the *exact* amount of each property for best performance under all conditions.

Here at Baash-Ross we've been making fishing taps so long that they've become second nature to us. We can supply you—in a hurry—with a tap to meet practically *any* requirement... tough on the inside and hard on the outside. If you want to circulate under pressure, we can put water-tight cutting threads on it. Or, we can fit a skirt and shoe to the tap for centering the fish, cutting clearance around it, and aligning the tap—*all in one operation.*

In fact, whatever you need in fishing taps you'll find Baash-Ross your *safest* bet for all-around satisfaction!

A NEW PLAN OF OIL AND GAS PROSPECTING —known as the geodynamic method—was discussed recently in a paper read before the A.I.M.E. This method is founded on the supposition that gas escapes from underground reservoirs to the surface in minute quantities. Measurement of such gas leakage at various points would be used in plotting an outline of an underlying oil or gas accumulation, according to the report. (No. C-51)

BAASH-ROSS

***NEW USES FOR ACIDS** in oil well production operations have recently been developed, according to reports. They include use of acid in dissolving drilling mud in the producing zone, cleaning screens and perforations, cleaning and completing salt water disposal wells, and in performing many other remedial jobs.*

BAASH-ROSS

THERE IS NO NEED to move the rotary table out of the rig when running casing. A Split Casing Bushing fits right into the table in place of regular master bushing and eliminates need for separate casing spider. Enables crew to handle casing at same level as drill pipe, increasing safety and saving run-in time as well as rig-up time. (No. C-52)

BAASH-ROSS

***IF SLIDE RULES BAFFLE YOU,** a 24-page booklet written by Don Herold, the famous humorist, should help you. Explains for the first time the difference between various types of slide rules and which type to use in your work. Easy to understand and helpful to any "figure workers." (No. C-53)*

BAASH-ROSS

For more details, simply send on a post card or letterhead, your name, address and key numbers of items that interest you.

3 SPEAR POINTS You Should Know About

Whether you use it to pull stuck casing or tubing—to set liners—to back-off pipe—or to perform any other fishing job...there's nothing that can touch the Baash-Ross Rotary Releasing Spear (1) for *more* grip... (2) for *uniform* grip, and...(3) for a *stronger* grip. Point by point, here's why...

1. More Slip Area. A Baash-Ross Spear not only has *longer* slips for a better hold *up and down* the pipe, but also *wider* slips for a better grip *around* the pipe!

2. Uniform Setting. An adjustment collar on the Baash-Ross Spear causes the slips to move *in unison* and conform to the pipe circumference *at all points* for uniform, overall grip!

3. Flat Slip-Bearing Surface. The extra-long, extra-wide slips on the Baash-Ross Spear act against a *flat* bearing surface, which substantially increases their gripping efficiency!

ALL these important features mean a more efficient hold on any fish and make for easier, faster removal. They prevent bulging or splitting of the pipe, even under hours of steady jarring.

For other points you'll want to know about this Baash-Ross Spear, simply get in touch with your nearest Baash-Ross representative or write direct. Find out about its easy, simple and *positive* operation...its outstanding advantages for safely working inside small diameters...its easy adaptability to *all* weights and sizes of tubing and casing.

(Leased in U.S.A.—Sold for export only)

Tables Turned On Oil Industry

You've probably read lately where chemists are figuring out a lot of new basic products made from oil—rubber, glycerine and explosives chief among many—in addition to the hundreds of oil by-products already on the market. But recently, chemists turned the tables on the oil industry, and now instead of making various products from oil, *they're making oil from something else!*

A recent report discloses that the United States Bureau of Mines has developed a hydrogenation process for *coal* which, if used to process the nation's coal reserves, could reportedly furnish enough oil to last *3,000 years,* based on the present crude consumption.

Yield of oil from coal is said to vary with the types processed, some yielding as high as two tons of oil for every three tons of coal, and others only half that much. Actual cost of oil produced from coal under perfected conditions has not been determined, but it is pointed out that long before our present petroleum supply is exhausted (if it is exhausted) the hydrogenation process would probably be so reduced in cost as to make oil from coal an auxiliary source of supply to draw upon.

ucts on the West Coast represents an important part of the distribution system there and it is not improbable that product lines will be constructed to offset current and prospective tanker losses.

A problem that may be easily as difficult as that of transportation will be that of determining what type and what volume of products should be emphasized. If next winter is long and severe large quantities of heating oil will be required and the building up of large preseason stocks will be necessary. If not, the building up of heating stocks could be minimized to some degree and thereby prevent a reduction in motor-fuel stocks to seriously low levels. Demand for residual fuel oil, expected to be by far the greatest in history, may be minimized by the substitution of coal and the extent to which such substitution is made. With the position between supply and demand of these major products on the East Coast reduced to a critical point wherein undue emphasis on one may cause a shortage in another, this part of the general problem assumes significant magnitude.

Will Use Coal at Refinery

Among pertinent developments last week was the announcement by the Standard Oil Co. of New Jersey that it would replace fuel oil with coal at its Bayway refinery in order to conserve the former, a lead which oil and other industrial concerns are expected to follow, and the issuance of a report on the tanker position of the Socony-Vacuum Oil Co., Inc. The report stated:

Of 19 Socony-Vacuum tankers, operating under the British flag, 4 have been lost as a result of torpedoing or bombing and 2 have been detained or seized in French ports. In addition, Standard-Vacuum Oil Co., Inc., a 50 per cent owned subsidiary with 10 tankers operating under the British flag, has lost 4 ships for similar causes, while 3 others have been damaged and are repaired or under repair.

The figures were announced in connection with a study which the company is making of its available tanker facilities, both for British service and for transportation from gulf ports to the Atlantic seaboard where a serious shortage of supplies is threatened.

Socony-Vacuum has two French flag tankers now believed to be held at Martinique and two tankers under Panamanian registry carrying Latin-American crude and products. Its present American flag fleet consists of 37 vessels of which 4 operate on the Pacific Coast and 33 from the Gulf to Atlantic seaboard. In meeting the U. S. Government request for additional tankers to transport oil products to the British, Socony-Vacuum has designated three of the latter group.

Socony-Vacuum Building Eight Tankers

To offset these losses and withdrawals, Socony-Vacuum is studying the possibility of increased shipments by pipe lines to the Atlantic seaboard even at greatly increased cost. It is engaged in a construction program of eight new tankers at an approximate cost of $18,500,000. Of these tankers two will be put in operation this year, four in 1942 and two in 1943.

Socony-Vacuum is to release another tanker by using two barge-tug units to move gasoline up the Mississippi and Ohio rivers to Pittsburgh, Pa. The company will heat its building at 26 Broadway, New York, with coal next winter saving 12,000 bbl. of fuel oil. Coal may be substituted for oil as fuel in the company's eastern refineries.

Tankers either under construction or on order now total 142, according to the May report of the American Bureau of Shipping, including the Maritime Commission contract for 72 tankers, 36 of 10,750 gross tons and 36 of 8,350 gross tons. While these vessels represent a gross tonnage of 1,354,260 tons, and would be more than ample to fill current needs, completion of this program is more than 2 years away.

Total Demand for All Oils Gains 3.2 Per Cent in 3 Months

WASHINGTON, D. C., May 20.—Increases in domestic demand for petroleum ranging from 0.6 per cent for crude to 44.5 per cent for wax during the first quarter sent total requirements for all oils to the new high total of 367,341,000 bbl. First-quarter demand for all oils this year was 3.2 per cent greater than for the same 3 months last year, according to the Bureau of Mines petroleum summary released here last week.

Domestic demand for motor fuel was 11.2 per cent greater for the first quarter than a year ago, compared to a gain of 12.4 per cent for the first 2 months.

The slump in exports continues with some products suffering more pronounced declines with the passage of time. Residual fuel-oil exports increased 12.1 per cent during the first quarter but shipments of other products have declined from 15.3 per cent in the case of motor fuel to 71.1 per cent on kerosene.

Imports of crude oil increased 38.9 per cent during the first quarter and total imports are up 18.5 per cent. A summary of Bureau of Mines statistics for March and the first 3 months is shown in the accompanying table.

UNITED STATES SUPPLY AND DEMAND

Three months, 1941 and 1940. (All figures in thousands of barrels)

Crude Oil

3 Months—	Total supply	Total demand	Excess demand	Excess Pct.	Domestic production	Imports	Indicated domestic demand‡	Exports	Stocks refinable crude Mar. 31§
1941	334,240	332,069	*2,171	*0.7	324,255	9,985	327,052	5,017	266,380
Daily average	3,714	3,690	.....	...	3,603	111	3,634	56	.....
1940	349,071	336,706	*12,365	3.7	341,883	7,188	325,131	11,575	251,120
Daily average	3,836	3,700	.....	...	3,757	79	3,573	127	.....
Increase, 1941	†14,831	†4,637	.....	...	†17,628	2,797	1,921	†6,558	15,260
	†4.2%	†1.4%	.....	...	†5.2%	38.9%	0.6%	†56.7%	6.1%

Refinery Products—Motor Fuel

3 Months—	Total supply	Total demand	Excess demand	Excess Pct.	Domestic production	Imports	Domestic demand	Exports	Stocks Mar. 31
1941	155,058	141,657	*13,401	*9.5	154,325	733	136,203	5,454	97,048
Daily average	1,723	1,574	.....	...	1,715	8	1,513	61	.....
1940	149,114	128,976	*20,138	*15.6	149,069	45	122,534	6,442	101,860
Daily average	1,638	1,417	.....	...	1,638	0.5	1,347	71	.....
Increase, 1941	5,944	12,681	.....	...	5,256	688	13,669	†988	†4,812
	4.0%	9.8%	.....	...	3.5%	.....	11.2%	†15.3%	†4.7%

Kerosene

1941	18,582	21,370	2,788	13.0	18,582	.....	21,031	339	6,724
1940	17,890	21,352	3,462	16.2	17,890	.....	20,178	1,174	4,114
Increase, 1941	692	18	.....	...	692	.....	853	†835	2,610
	3.9%	0.08%	.....	...	3.9%	.....	4.2%	†71.1%	63.4%

Distillate Fuel and Residual Fuel Oil¶

1941	139,810	162,067	22,257	13.7	128,871	10,939	155,461	6,606	112,908
1940	138,742	154,997	16,255	10.5	128,788	9,954	147,056	7,941	112,437
Increase, 1941	1,068	7,070	.....	...	83	985	8,405	†1,335	471
	0.8%	4.6%	.....	...	0.06%	9.9%	5.7%	†16.8%	0.4%

Distillate Fuel Oils

1941	48,333	61,894	13,561	21.9	47,076	1,257	58,471	3,423	30,009
1940	50,056	61,373	11,317	18.4	49,156	900	56,272	5,101	23,086
Increase, 1941	†1,723	521	.....	...	†2,080	357	2,199	†1,678	6,923
	†3.4%	0.8%	.....	...	†4.2%	39.7%	3.9%	†32.9%	30.0%

Residual Fuel Oils

1941	91,477	100,173	8,696	8.7	81,795	9.682	96,990	3,183	82,899
1940	88,686	93,624	4,938	5.3	79,632	9,054	90,784	2,840	89,351
Increase, 1941	2,791	6,549	.....	...	2,163	628	6.206	343	†6,452
	3.1%	7.0%	.....	...	2.7%	6.9%	6.8%	12.1%	†7.2%

Lubricating Oils

1941	8,278	8,409	131	1.6	8,278	.....	6,428	1,981	8,637
1940	9,751	8,809	*942	*10.7	9,751	.....	5,459	3,350	8,084
Increase, 1941	†1,473	†400	.....	...	†1,473	.....	969	†1,369	553
	†15.1%	†4.5%	.....	...	†15.1%	.....	17.8%	†40.9%	6.8%

Petroleum Wax (Thousands of pounds)

1941	137,986	141,371	3,385	2.4	135,240	2,746	103,426	37,945	121,887
1940	161,334	146,609	*14,725	*10.0	145,320	16,014	71,558	75,051	90,373
Increase, 1941	†23,348	†5,238	.....	...	†10,080	†13,268	31.868	†37,106	31,514
	†14.5%	†3.6%	.....	...	†6.9%	†82.9%	44.5%	†49.4%	34.9%

*Excess supply. †Decrease. ‡Crude only. §Includes finished and unfinished refinery gasoline and natural gasoline. ¶Distillate fuel and residual fuel oil equals distillate fuels plus residual. Note: Total supply equals domestic production plus imports. Total demand equals domestic demand plus exports. Data on demand for refined products based on refinery shipments. ‖Does not include 11,776,000 bbl. of heavy oils in California. Comparable figures for March 31, 1940, 13,485,000.

Crude Oil Run to Stills and Total All Oils

3 Months—	Total imports§	Total exports§	Total crude to stills	Per cent yield gasoline‡	Natural gasoline production	Total supply all oils*	Total demand all oils*	Stocks all oils Mar. 31*
1941	22,904	20,152	322,187	43.2	14,365	362,434	367,341	559,047
Daily average	254	224	3,580	....	160	4,027	4,082	.....
1940	19,332	31,649	318,375	42.6	12,939	374,894	355,821	543,843
Daily average	212	348	3,499	....	142	4,120	3,910	.....
Increase, 1941	3,572	†11,497	3,812	....	1.426	†12,460	11,520	15,204
	18.5%	†36.3%	1.2%	....	11.0%	†3.3%	3.2%	2.8%

*Total all oils includes crude and refined products, natural gasoline, and benzol. Stocks March 31, 1941, represented 137 days' supply, which compares to 139 days on the same date in 1940. †Decrease. ‡Does not include natural gasoline blended at refineries. §Includes crude oil and refinery products. In case of imports includes receipts in bond for domestic use. All data based on Bureau of Mines report.

Refinery Expansion

Expenditures by Refineries Exceed All Industries

The United States petroleum-refining industry led a list of 445 industries in expenditures for new buildings, tools, machinery, transportation facilities, office equipment and other items of expansion in a compilation released recently by the Bureau of Census.

The report shows that a total of $1,337,588,872 was spent for plant and equipment in 1939 by the 445 industries. Of this total the petroleum refining industry spent $111,535,112 or 8.3 per cent of the total of all the 445 industries covered in the report.

This expenditure by the petroleum-refining industry was larger than any other single industry group. The following tabulation shows the leading industries based on the amounts spent for plant and equipment:

Industry—	Total expenditures for plant and equipment in 1939	Per cent of total
Petroleum refining	$111,535,112	8.3
Steel works and mills	87,922,955	6.6
Motor vehicles, bodies, etc.	76,331,179	5.7
Chemicals	47,665,056	3.6
Paper mills	37,501,951	2.8
Baker products	36,118,781	2.7
Nonalcoholic beverages	24,122,464	1.8
Sawmills, etc.	23,443,262	1.8
Cotton broad-woven goods	23,028,820	1.7
Malt liquors	22,898,210	1.7
Aircraft and parts	22,580,284	1.7
434 other industries	824,440,798	61.6
Total	$1,337,588,872	100.0

During 1939 the petroleum refineries which made this expenditure for plant and equipment sold products worth $2,420,596,764 or an average of approximately $6,630,000 per day. On the average it took the total sales of all these companies 17 days of the year to build and purchase new facilities. The average for all 445 industries equaled the expenditure of 10 days' sales for new plants and equipment.

Frontier Completes New Unit at Buffalo, N. Y., Plant

BUFFALO, N. Y.—A new refining unit with capacity of 6,000 bbl. daily has been completed by Frontier Oil Corp. at its river road plant in Buffalo, N. Y.

Crude supplies for the Frontier plant are drawn mostly from Illinois. Delivery is effected by pipe lines to the Great Lakes and from there to the firm's Niagara River terminal via lake tankers and barges.

James F. Breuil is president of Frontier company which has operated a 2,500-bbl. skimming and asphalt plant at Buffalo for several years.

Omar to Reopen Plant At Garber, Okla.

Reconditioning work on Omar Refining Co.'s plant at Garber, Okla., which has been shut down for almost 2 years, is continuing and the plant will be opened about June 1. The plant has a crude-oil capacity of 5,000 bbl. and a 2,000-bbl. cracking capacity. Crude from the Oklahoma City field will be processed when the plant begins operations.

Bareco Resumes Operations At Corpus Christi Plant

HOUSTON, Tex.—Bareco Oil Co., Tulsa, has resumed operations at its refinery at Corpus Christi, Tex. The 10,000-bbl. plant, built some 3 years ago, has been closed down for over 1 year. The plant has a 5,500-bbl. Dubbs cracking unit. A. B. Comstock, formerly chemist at the company's Okmulgee, Okla., refinery prior to its being shut down, is superintendent of the Corpus Christi plant.

Natural Gasoline

Natural-Gasoline Yield Drops Slightly in March

Daily average production of natural gasoline in March declined to 6,660,000 gal., the Bureau of Mines reported last week, compared to 6,848,000 gal. daily in February. The chief decreases in daily output in March were in the Texas Panhandle, Kettleman Hills and Kansas.

Stocks of natural gasoline increased slightly to a total of 223,902,000 gal. at the end of March compared with 223,062,000 gal. on February 28 and 226,506,000 gal. at the end of March a year ago.

Shipments of natural gasoline to refinery-owned bulk plants and to jobbers and retailers in March increased 378,000 gal. and 1,302,000 gal., respectively, over February 1941. Exports decreased from 2,982,000 gal. in February to only 84,000 gal. in March.

The average vapor pressure decreased for shipments to refineries and to jobbers and retailers, and increased for all other shipments. The weighted average for the month was 19.8 lb., compared with 20.7 lb. in February and 20.3 lb. in March 1940.

	Production, thousands of gallons			
	Mar. 1941	Feb. 1941	Jan.-Mar. 1941	Jan.-Mar. 1940
East Coast				
Appalachian	9,118	8,502	26,911	25,046
Ill., Mich., Ky.	5,057	4,412	14,323	6,397
Oklahoma:	31,612	28,498	91,626	96,971
Oklahoma City	6,187	5,689	18,413	21,095
Osage County	4,559	4,087	12,664	12,163
Seminole	8,969	7,808	25,582	27,161
Rest of state	11,897	10,914	34,967	36,552
Kansas	6,258	6,712	19,821	17,057
Texas:	86,011	80,399	250,183	201,166
Gulf	20,558	19,360	60,053	39,149
East Texas	13,211	11,599	37,300	41,081
Panhandle	22,907	23,257	68,516	65,907
North Texas	2,126	2,000	6,306	7,171
West Central	5,104	4,777	15,209	16,124
Rest of state	22,105	19,406	62,799	31,734
Louisiana	10,022	9,126	28,423	25,942
Arkansas	2,892	2,530	8,328	6,174
Rocky Mountain	7,895	7,059	22,830	20,357
California	47,607	44,492	140,885	144,328
Huntington Beach	2,579	2,332	7,475	7,972
Kettleman Hills	9,263	9,373	29,118	31,042
Long Beach	7,485	6,780	21,692	21,836
Santa Fe Springs	4,726	4,258	13,646	14,040
Ventura Avenue	4,871	4,546	14,448	15,819
Rest of state	18,683	17,203	54,506	53,619
Total	206,472	191,730	603,330	543,438
Daily average	6,660	6,848	6,704	5,972
Total (thousands of barrels)	4,916	4,565	14,365	12,939
Daily average	159	163	160	142

Recycling News

Lone Star Planning Recycling Plant for Willow Springs

DALLAS, Tex.—Lone Star Gas Co. is planning construction of a $300,000 gas-recycling plant on properties in the Willow Springs field of Gregg County, East Texas. The company earlier this month purchased a one-half interest in the properties from Roger Lacy of Longview, Tex., the purchase including two gas-distillate wells, a drilling well and considerable acreage.

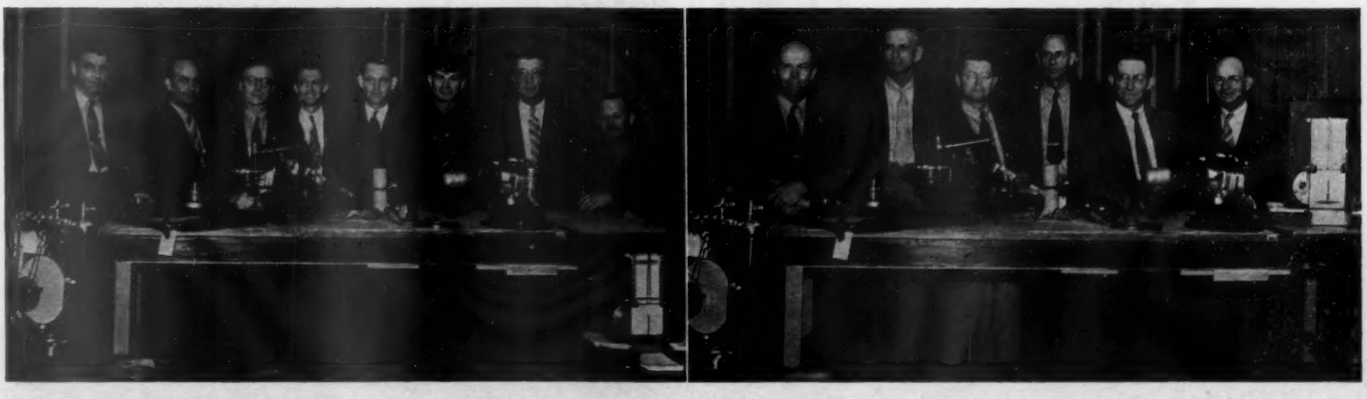
●

Noelke Pipe Line Obtains Charter

A charter of incorporation has been granted the Noelke Pipe Line Co. with capital stock of $10,000 for the construction of lines in the Iraan oil field of West Texas.

The incorporators were listed as G. T. Kimbell, C. J. Bohner and Knox L. Garvin.

CALIFORNIA NATURAL-GASOLINE GROUP DEVOTES MEETING TO GADGET SHOW



A gadget exhibition featured the May meeting of the California Natural Gasoline Association. Among those participating were (left to right): J. R. Brick, Southern California Gas Co.; R. N. Gingles, Standard Oil Co. of California; Bennett Schock, General Petroleum Co.; D. L. Teeter, Standard Oil Co. of California; E. D. Smyser, C. C. M. O. Co.; C. A. Davis, Texas Co.; E. F. Ruppert, Southern California Gas Co.; T. T. Rissinger, Union Oil Co.; K. D. Eastman, General Petroleum Corp.; E. Newman, Gilmore Dabney, Inc.; Chet Beard, C. C. M. O. Co.; Lew Stephens, C. C. M. O. Co.; J. P. Ioppini, Belridge Oil Co.; J. A. Swindle, General Petroleum Co.

QUALITY UNCOMPROMISED

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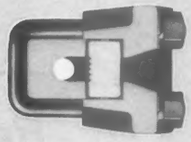
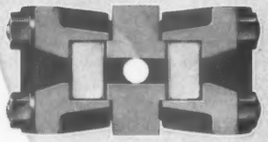
Reflex
DROP FORGED STEEL LIQUID LEVEL GAGES

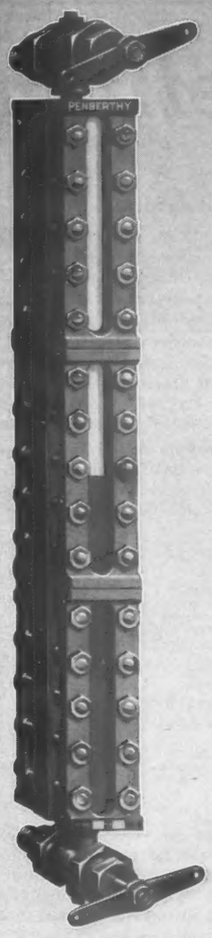
Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.



PENBERTHY
Transparent
DROP FORGED STEEL LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.





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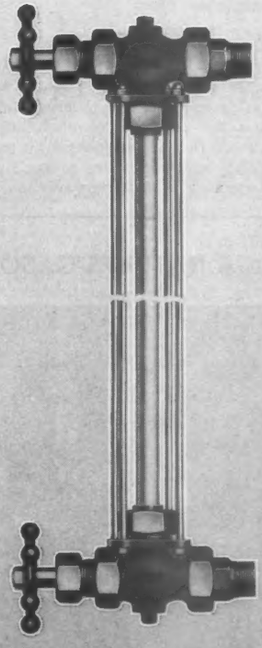
ALL PENBERTHY GAGES
CONFORM WITH A. P. I.—A. S. M. E. REQUIREMENTS

PENBERTHY
Reflex
WATER GAGE SET

Water shows black—steam shows white. U-bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.

PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES

Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.



PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • Canadian Plant: Windsor, Ontario

PENBERTHY PRODUCTS

PROGRAMS AND MEETINGS

Oil Scouts All Set for Meeting in Dallas

Arrangements have been completed for the 1941 annual convention of the National Oil Scouts and Landmen's Association, to be held in Dallas, Tex., May 29-31. Headquarters will be the Adolphus Hotel.

Highlighting the program will be addresses by Dr. Joseph E. Pogue, vice president, Chase National Bank of New York, and Martin Dies, member of Congress from Texas. Dr. Pogue will speak on "Regulation Without Regimentation: The Oil Industry's Contribution to Our Economy." Mr. Dies will address the convention on "The Enemies Within." Dr. Pogue has been closely identified with the petroleum industry for many years, and is the author of many books and scientific articles. Mr. Dies is chairman of the Dies Committee investigating un-American activities. He is serving his sixth term in Congress, and is a member of the rules committee.

The Cameron Iron Works, Houston, Tex., will show movies at the convention on "The Capping of Wild Wells."

The Dallas Petroleum Club has extended a welcome to the members of the association to its eighteenth annual convention, and has extended to them the privileges of its club lounge for the duration of the convention.

C. J. Bradley, Texas Co., Tyler, Tex., is president of the National Oil Scouts and Landmen's Association, and R. H. Weaver, Sun Oil Co., Jackson, Miss., is chairman of the convention committee.

Petroleum Division, A.S.M.E., to Hear Nine Papers at Kansas City Meeting

The Petroleum Division of the American Society of Mechanical Engineers will hold its annual meeting cooperatively and concurrently with the main meeting of the society and will sponsor, as a part of the semi-annual meeting program, nine important papers on petroleum subjects. The program, as announced by W. F. Herbery, Texas Co., Fort Worth, Tex., and who is chairman of the division, is as follows:

Monday, June 16

Morning session.

"Motor Fuels and Their Substitutes," by Dr. Gustav Egloff, Universal Oil Products Co.

"The Selection of Mechanical Equipment for Use in Oil Fields," by Emory Kemler and C. R. Freberg, Purdue University.

"Sucker-Rod Pumping," by S. B. Sargent, Jr., and R. W. Rieniers, Huntington Park, Calif.

Tuesday, June 17

Morning session.

"The Development of Steels and Alloys for Use at Elevated Temperatures in Petroleum Refineries," by B. B. Morton, International Nickel Co., Inc.

"Calibration of Displacement Meters on Volatile Liquid-Petroleum Fractions," by E. W. Jacobson, Gulf Research & Development Co., Pittsburgh, Pa.

Wednesday, June 18

Morning session.

"Liquification and Regasification of Lighter Hydrocarbons," by F. W. Laverty, Clark Brothers Co., Inc., Olean, N. Y.

"Subsurface Instruments Used in Petroleum Engineering," by P. G. Exline, Gulf Research & Development Co., Pittsburgh, Pa.

Afternoon session.

"Measurement of Properties of Natural-Hydrocarbon Systems at Reservoir Pressures and Temperatures," by Kenneth Eilerts, Bureau of Mines, Bartlesville, Okla.

"Manufacture of Synthetic Rubber From Petroleum Products," by J. H. Boyd, Jr., Hydrocarbon Chemical & Rubber Co., Bartlesville, Okla.

Oil-Tax Meeting Will Be Held This Week

The next dinner meeting of the petroleum tax representatives of the Kansas-Oklahoma area will be held at 6:15 p.m. Friday, May 23, in the Ivory Room of the Mayo Hotel, Tulsa, L. W. Bennett, Sunray Oil Co., will preside.

J. W. Lenon, field representative, National Highway Users Conference, Dallas, Tex., will give an address on the subject, "The Effect of the Proposed Increase in the Federal Gasoline Tax on Highway Users."

M. M. Lawellin, trust officer, First National Bank & Trust Co., Tulsa, will speak on "The Effect of Bond Issues on the Ad Valorem Tax Burden."

Judge J. H. Hill, chief Oklahoma counsel, Texas Co., Tulsa, will speak on the subject, "The Case Against a Tax on Fuel Oil."

Petroleum Accountants Hold Final Meeting of Fiscal Year

The final meeting for the fiscal year of the Petroleum Accountants Society was held at the Tulsa Country Club on Friday, May 16.

In keeping with the custom followed in prior years, the usual formalities prevailing at the regular business meetings were dispensed with and the evening was devoted to entertainment, amusement, and the furtherance of acquaintanceship among the members.

California Natural-Gasoline Men Plan June Frolic

Under chairmanship of H. E. Leedy, of the Crane Co., the committee in charge of the program for the 1941 June Frolic of the California Natural Gasoline Association announces the event will be held at the Riviera Country Club, Santa Monica, Calif., Saturday, June 7.

This annual sports-fun fiesta will find the daytime devoted to a sports program with the first of the golfers teeing off at 8:30 a.m., a program of diversified sports events during the afternoon featuring a baseball game between the majors and independents, volley ball, horseshoes, and badminton. Tired and thirsty sportsters will find refreshments available without charge during the day. The evening program will feature a banquet.

According to Mr. Leedy, whose committee consists of Gordon Greene, Robinson Orifice Fitting Co.; Walt Landis, Crane Co.; George Christian, Crosby Steam Gage & Valve Co.; Harry Fiske, Ingersoll-Rand Co.; Glenn Gill, J. B. Gill Corp., and Harold Dresser, Flour Corp., the event is open to all natural-gasoline, refinery, natural-gas, and men from allied industries interested in attending.

CALENDAR OF EVENTS

May

AMERICAN PETROLEUM INSTITUTE, eleventh midyear meeting, Mayo Hotel, Tulsa, May 19-22.

NATIONAL ASSOCIATION OF PURCHASING AGENTS (Oil Company Buyers' Group), Stevens Hotel, Chicago, May 26-29.

NATIONAL OIL SCOUTS AND LAND MEN'S ASSOCIATION, annual convention, Dallas, Tex., May 29-31.

June

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting, Greenbrier Hotel, White Sulphur Springs, W. Va., June 1-6.

OIL MEN'S GOLF TOURNAMENT AND BARBECUE, seventh annual, Stockdale Country Club, Bakersfield, Calif., June 7.

ILLINOIS-INDIANA PETROLEUM ASSOCIATION, ninth annual petroleum conference, Robinson, Ill., June 7.

LIQUEFIED PETROLEUM GAS ASSOCIATION, INC., Pacific Coast section, Fairmont Hotel, San Francisco, Calif., June 9-10.

KENTUCKY OIL AND GAS ASSOCIATION, midyear meeting, Lexington, Ky., June 20-21.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting of Petroleum Division, Kansas City, Mo., June 16-20.

PENNSYLVANIA GRADE CRUDE OIL ASSOCIATION, annual meeting, Bradford, Pa., June 19-20.

LITTLE INTERNATIONAL OIL SHOW, second annual exposition, Odessa, Tex., June 21-22.

AMERICAN SOCIETY FOR TESTING MATERIALS, forty-fourth annual meeting, Palmer House, Chicago, June 23-27.

September

AMERICAN CHEMICAL SOCIETY, Atlantic City, N. J., September 8-12.

NATIONAL PETROLEUM ASSOCIATION, thirty-ninth annual meeting, Hotel Traymore, Atlantic City, N. J., September 17-19.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting, Schroeder Hotel, Milwaukee, Wis., September 25-26.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Petroleum Division, East Texas chapter, annual convention, Adolphus Hotel, Dallas, Tex., September 25-27.

NATIONAL LUBRICATING GREASE INSTITUTE, ninth annual meeting, Stevens Hotel, Chicago, September 29-30.

October

TEXAS MID-CONTINENT OIL AND GAS ASSOCIATION, twenty-second annual convention, Beaumont, Tex., October 9-11.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Petroleum Division, Dallas, Tex., October 16-18.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aircraft production meeting, Biltmore Hotel, Los Angeles, Calif., October 30-November 1.

CALIFORNIA NATURAL GASOLINE ASSOCIATION, Los Angeles, Calif., October 31.

November

AMERICAN PETROLEUM INSTITUTE, twenty-second annual meeting, San Francisco, Calif., November 3-7.

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, Pacific section, Los Angeles, Calif., November 6-7.

December

NEW MEXICO OIL AND GAS ASSOCIATION, Artesia, N. M., December 3.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Southeastern district meeting, New Orleans, La., December 3-5.

Oil and oranges, side by side. International U-6 Power Unit operating a well in the East Coyote field near Placentia, Calif. The U-6 develops 41 h.p. at 1,500 r.p.m.

Typical power unit installation in the West Texas-New Mexico Permian Basin near Odessa, Texas. International U-4 shown. Develops 31.5 h.p. at 1,800 r.p.m.

Dependable Power in Any Setting

NO MATTER where wells are drilled or oil is pumped—in a California orange grove or on the broad sweep of the Texas plains—you'll find International Power Units and Diesel TracTracTors furnishing dependable power.

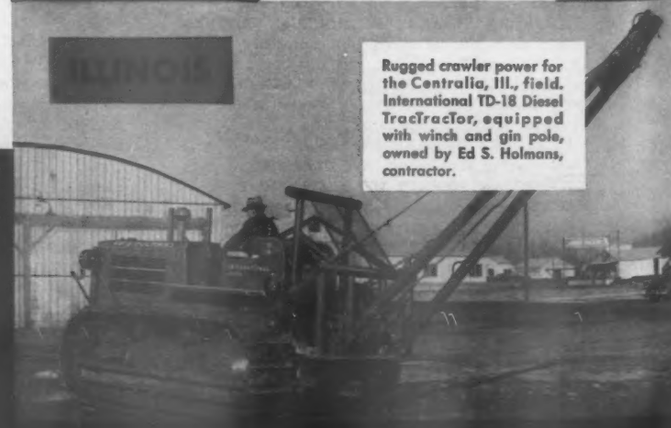
Oil field settings aren't standardized—International Power Equipment standardization is another matter. It means the opportunity to build a coordinated equipment program around the International line, to choose from a wide range of engine, tractor, and truck models, and to get the benefit of International after-sale service.

International Power Units are made in sizes up to 110 max. h.p. for Diesel, natural gas, gasoline, and distillate fuel. *International Diesel TracTracTors,* in four sizes, are ideal for digging slush pits, cleaning and servicing wells, pulling rods, laying pipe line, etc. The new *International Industrial WHEEL Tractors* have many applications in oil field work. And in the complete new line of *International Trucks,* oil men are finding the performance and stamina they have always associated with International.

See the International Industrial Power dealer or Company-owned branch in your locality. Ask for a demonstration.

INTERNATIONAL HARVESTER COMPANY
180 North Michigan Avenue Chicago, Illinois

International U-2 Power Unit at work in Brazil's Labato field, on the outskirts of Salvador, capital of Bahai. The U-2 develops 22 h.p. at 1,800 r.p.m.



Rugged crawler power for the Centralia, Ill., field. International TD-18 Diesel TracTracTor, equipped with winch and gin pole, owned by Ed S. Holmans, contractor.

INTERNATIONAL
INDUSTRIAL POWER

A.P.I. SECTION

Technical papers and digests of papers presented at the semiannual meeting, American Petroleum Institute, Tulsa, May 19—22

Additional reports of the meeting on Pages 38—39

In This Section

Complete Papers . . .

MUD FLOW IN DRILLING
By R. J. S. Pigott ..... Page 62
A revision of a study completed in 1931 on the flow of mud in pipe, well bores and mud pits, and on the lifting and releasing properties for cuttings is presented.

CATHODIC PROTECTION OF OPEN-TANK CONDENSERS
By N. A. Miller ..... Page 66
The same general principles of cathodic protection which have been successfully applied to pipe lines are equally applicable to protection of open-tank condensers. Costs are relatively low in comparison with possible savings.

ECONOMICS OF FLUE-GAS RECIRCULATION AND ECONOMIZERS IN FIRED TUBULAR HEATERS FOR OIL REFINERIES—By C. C. Nelson ..... Page 71
Economic factors underlying the general trend away from the use of flue-gas recirculation and air-preheater systems are examined and performance tests studied.

CORE-ANALYSIS INTERPRETATION
By Norris Johnston ..... Page 76
Core analysis has reached a stage of development in which it is a most useful tool for the study of reservoir properties. The present state of knowledge on the subject is discussed.

CORROSION PREVENTION ON WATER SIDE OF REFINERY EQUIPMENT
By W. H. Attwill and V. L. Nealy ..... Page 81
In the first portion the chemical treatment of water is discussed; in the second, use of the deaerator; and in the third portion application of cathodic protection is described.

AIR PREHEATERS FOR PETROLEUM HEATERS
By L. A. Mekler and H. A. Becker ..... Page 88
As large amounts of fuel are consumed in refinery operations, fuel savings are an economic necessity. Installation of air heaters may save up to 25 per cent of the fuel used by heaters.

GENERATION OF STEAM AS A FACTOR IN MODERN-REFINERY HEAT ECONOMY
By W. W. Kraft, Valentine Mekler and R. H. Riemenschneider ..... Page 110
Steam generation and its effect upon selection of pumps and reduction in utilities consumption are outlined and typical installations are discussed and illustrated.

PRESSURE-CORE ANALYSIS
By J. J. Mullane ..... Page 118
The author shows a more complete analysis of the core now can be obtained, and that usefulness of core analysis has been extended considerably.

USE OF DEPTH-PRESSURE DATA IN DETERMINATION OF WELL POTENTIALS IN CALIFORNIA—By R. W. French, M. W. Morris, E. G. Trostel and J. C. Young ..... Page 150
Hazards of extrapolating the mean producing pressure-rate curve are discussed, and minimum practical mean producing pressures are calculated. Present status of special studies is given.

Digests of Papers . . .

EVALUATION OF DIESEL FUELS IN FULL-SCALE ENGINES—By W. G. Ainsley ..... Page 133
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1940 ROAD DETONATION TESTS—By J. M. Campbell, R. J. Greenshields and W. M. Holaday ..... Page 138
REGENERATIVE-TYPE AIR HEATERS FOR REFINERY USE—By O. F. Campbell and T. B. Kimball ..... Page 138
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WATER-SIDE CORROSION OF REFINERY CONDENSING EQUIPMENT—By B. B. Morton ..... Page 142

Mud Flow in Drilling

By R. J. S. PIGOTT
Gulf Research & Development Co., Pittsburgh, Pa.

A.P.I.

This paper is a revision of the study completed in 1931 on the flow of mud in pipe, well bores, and mud pits, and on the lifting and releasing properties for cuttings.

Tests made by Gregory on 4-in. pipe; by Ambrose and Loomis on capillary tubes; also on ½ and 1-in. pipe and a modified McMichael absolute viscosimeter were used to demonstrate that the flow of mud can be predicted in the viscous region by utilizing the variable apparent viscosity in place of the usual constant viscosity for a liquid.

In the turbulent region of flow all plastic effects and, consequently, variation of viscosity disappear; then mud can be treated as a true liquid. Experiments show that in this region the viscosity of mud is surprisingly low. The two different formulas which must be used for suspension of cuttings respectively in viscous and turbulent flow are discussed, together with modifications necessary for cuttings other than round particles.

Calculations of resistance to flow in various parts of the mud-pumping system are given for several cases as illustrations based on friction factors taken from the writer's 1933 paper before the American Society of Mechanical Engineers.

Paper was presented before the Division of Production, at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

THE paper, "Hydraulics of Mud-Circulating Systems," by Wesley W. Moore,* presented at the November 1940 meeting in Chicago reminded the writer that we had undertaken a similar study in 1931. The results were not published; but as this study covered the subject further than Mr. Moore's paper, it may be worth giving the results, which are just as reliable today as when they were made 10 years ago.

The properties required of muds for lifting cuttings out of the hole, suspending them when circulation is stopped, and dropping them in the mud pit, frequently are opposed, and we must select the compromise properties, giving the best average results. Part of the hole, and generally all of the mud pit, are in viscous flow; the rest of the system is largely in turbulent flow. As the behavior of cuttings follows different laws in these two regions, it is necessary to take both conditions into account in determining flow conditions.

Lifting and Dropping Cuttings

In viscous flow no turbulence occurs, and Stokes law applies:

$$v = \frac{2gd^2}{36}\,\frac{(\rho_1 - \rho_2)}{\mu} \quad \text{for round particles} \qquad (1)$$

In turbulent flow, Rittinger's formula is:

$$v = 9\sqrt{\frac{d(\rho_1 - \rho_2)}{\rho_2}} \quad \text{for round particles} \qquad (2)$$

Where:

v = slip velocity of particle, feet per second
ρ_1 = density of cutting, pounds per cubic foot
ρ_2 = density of mud, pounds per cubic foot
d = diameter of round particle, on the greatest dimension if a flat particle, feet
μ = viscosity, Reyns (= centipoises × 0.000672)

For flat cuttings, a further modification of the formulas occurs, which cuts the slip velocity down for a given particle size. Experience from the elutriation data developed in ore classification and similar fields give us the necessary constants.

For flat particles, such as shale and most stone cut by a drill, the required velocity is lowered, because the cutting tends to be carried up in the position of greatest resistance to flow past it; i.e., broadside to the flow. Even a streamlined body, contrary to general belief, will fall broadside on in a stationary liquid or be lifted flatwise in a vertical stream. Because cuttings vary in general shape, no single constant exactly represents the conditions, but ore classification and similar commercial elutriation practice, such as filtration and concentration, indicate average velocity to lift flattish pieces to be about 40 per cent of that required for round cuttings such as sand.

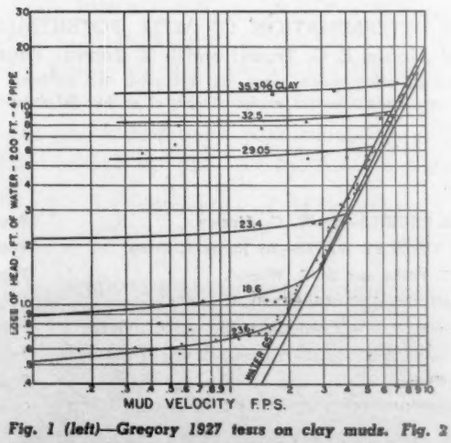
Ambrose and Loomis, in their later work,[2] use a value of about 73 per cent, using a lower constant for round particles and a higher one for average flat particles.

The flow formulas for flattish particles become:

$$\text{Stokes, viscous flow } v = \frac{2gd^2}{92.6}\,\frac{(\rho_1 - \rho_2)}{\mu} \qquad (3)$$

$$\text{Rittinger, turbulent } v = 3.5\sqrt{\frac{d(\rho_1 - \rho_2)}{\rho_2}} \qquad (4)$$

Muds are not true liquids, but all show a certain amount of plasticity in addition to viscosity, which would be expected of material containing colloids. W. B. Gregory's study in clay slurries[1] gave some of the earliest reliable data. Gregory experimented in 4-in. pipe, 200 ft. long on six "slurries" (clay muds with a little sand), from about 0.1 to 10 ft. per second velocity. The tests are shown in Fig. 1, velocity against pressure (feet of water). These tests show two important facts. The pressure remains practically constant at all velocities up to the critical, where the flow breaks over from viscous to turbulent. This means that the apparent viscosity is varying inversely with velocity so that $\mu_a v = constant$. The other important fact is that after turbulence has been attained, the muds behave as true liquids. In spite of the relatively high percentage of solids, the turbulent-region viscosity is surprisingly low—only a little greater than that of water.



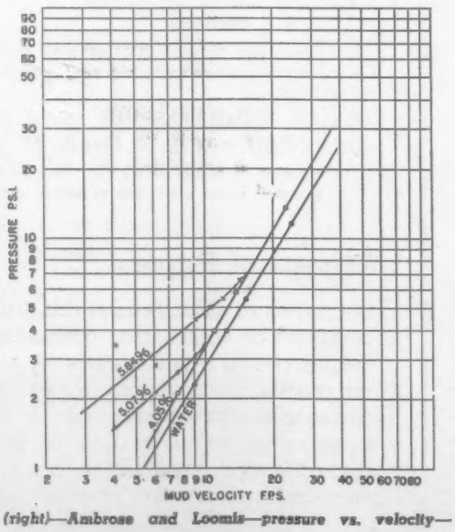


Fig. 1 (left)—Gregory 1927 tests on clay muds. Fig. 2 (right)—Ambrose and Loomis—pressure vs. velocity—bentonite muds (½-in. o.d., 14.5-ft. long tubing)

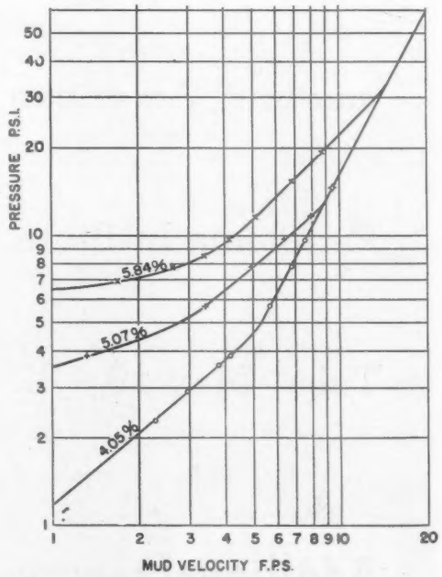
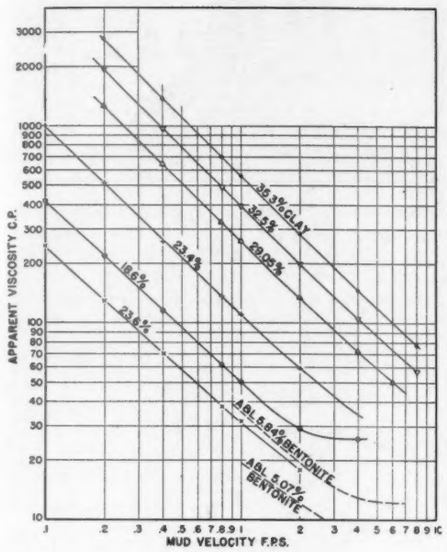


Fig. 3—Ambrose and Loomis —pressure vs. velocity—bentonite muds (1-in. o.d., 176.6-ft. long tubing)

Ambrose and Loomis[2 3] have presented further data on the situation. They worked from capillary tubes up to a pipe viscosimeter, built by the

*Production Bull. 226, p. 26-31.



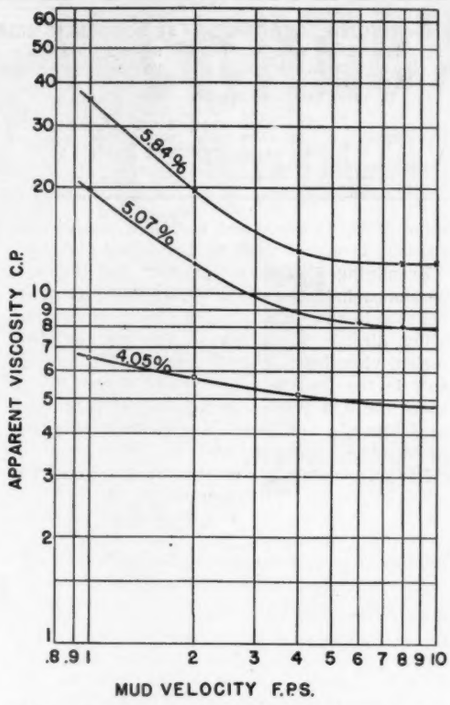


Fig. 4 (above)—Apparent viscosity—viscous-region flow—Gregory clay muds; turbulent-region viscosity, 1.0 to 1.2 centipoises, constant. Fig. 5 (right)—Ambrose and Loomis—bentonite muds (½-in. and 1-in. o.d. tubing); turbulent viscosity, 2.5 centipoises

writer, to get diameter effects. The ½-in. and 1-in. pipe tests were made on this apparatus. From this point they developed a modification of the McMichael absolute viscosimeter for further work.

Their results on 4 to 6 per cent bentonite mixtures are given in Figs. 2 and 3. Some generalizations can be made from these studies. The Gregory experiments show that the constant turbulent viscosity, plus a pressure p to overcome the plastic resistance, represents the test results very well. These muds contained relatively little colloidal-size material. The Ambrose and Loomis experiments were made on highly colloidal material. In this case, a plastic deformation pressure p, and constant viscous-region viscosity, also will satisfy the tests; but this viscosity is several times higher than the turbulent-region viscosity for the same tests. In both sets of experiments, the plastic pressure p disappears after breakover, and the muds behave as true liquids. It should be pointed out again that the so-called critical velocity is not a fixed quantity for any given fluid, but varies with the diameter or, rather, with the mean hydraulic radius. In general, with thixotropic fluids, the critical velocity cannot be calculated direct by using the Reynolds number, because the critical velocity does not occur at the usual values, but generally much higher.

The analysis of viscosimeter readings, or pipe flow tests, for the plastic pressure and viscous-region viscosity is too clumsy and tedious to use for practical work. Fortunately, we have a much more convenient method.

A complete apparent viscosity curve for any mud may be obtained from an absolute viscosimeter. Then the usual viscous and turbulent-region formulas can be used to calculate pressure drops for any kind of conduit.[4]

These formulas are:

$$p = \frac{0.00691\ \mu l v}{d^2} \quad \text{viscous flow, circular pipes} \qquad (5)$$

$$p = \frac{0.000432\ \mu l v}{M^2} \quad \text{viscous flow, any other shape} \qquad (6)$$

$$p = \frac{0.000108\ f l \rho v^2}{d} \quad \text{turbulent flow, circular pipes} \qquad (7)$$

$$p = \frac{0.000027\ f l \rho v^2}{M} \quad \text{turbulent flow, any other shape} \qquad (8)$$

Where:

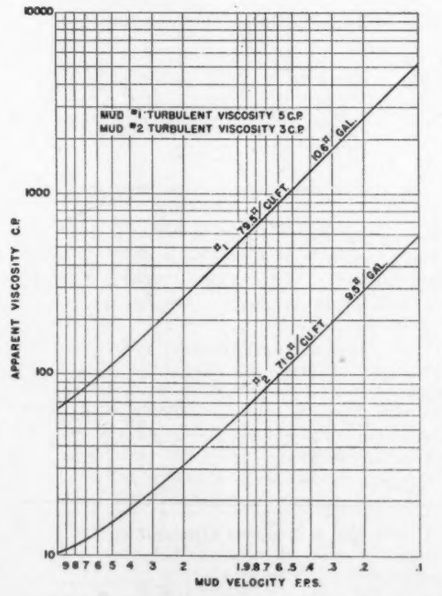
p = pressure drop, pounds per square inch.
μ = apparent viscosity, feet-per-second units (= centipoises × 0.000672).
l = length of pipe, feet.
v = velocity, feet per second.
d = diameter of pipe, feet.
ρ = density of mud, pounds per cubic foot.
M = mean hydraulic radius, feet (= area, square feet, divided by total perimeter, feet).

For example, the mean hydraulic radius for the annulus between drill pipe and casing or drill pipe and hole is:

$$\frac{\frac{\pi}{4}(D_2^2 - D_1^2)}{\pi (D_2 + D_1)} = \frac{D_2 - D_1}{4}$$

The critical velocity can be obtained for any mud and any conduit by calculating turbulent flow (Formula 7 or 8) and plotting on log paper. This is a straight line. Now viscous flow is calculated by Formula 5 or 6, up to high enough velocity so it crosses the turbulent line. The intersection will be at the critical velocity. Fig. 4 shows the apparent viscosity of the six muds in Gregory's paper.[1] The essential data are given in Table 1.

Fig. 5 shows the viscosities for the Ambrose



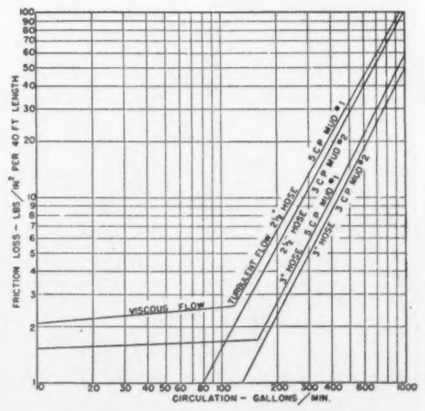

FRICTION LOSS - LBS./IN.² PER 40 FT. LENGTH
CIRCULATION - GALLONS/MIN.
VISCOUS FLOW
TURBULENT FLOW
2½" HOSE 5 C.P. MUD #1
2½" HOSE 3 C.P. MUD #2
3" HOSE 5 C.P. MUD #1
3" HOSE 3 C.P. MUD #2

Fig. 6 (left)—Typical muds—apparent viscosity vs. velocity in viscous region. Fig. 7 (bottom)—Friction factor f. Fig. 8 (right, below)—Fluid friction loss in 40-ft. lengths of 2½-in. and 3-in. rotary hose with muds having viscosities of 3 and 5 centipoises in turbulent region

TABLE 1—GREGORY MUDS: SOLIDS AND DENSITIES

	Solids (per cent by weight)	Solids (per cent by volume)	Density (lb. per cu. ft.)	Lb. per gal.)
1	18.6	7.9	70.3	9.4
2	23.4	10.2	72.7	9.7
3	23.6	10.7	73.2	9.8
4	29.05	13.2	75.9	10.1
5	32.5	15.2	77.9	10.4
6	35.3	16.9	79.7	10.7

TABLE 2—VISCOSITIES OF BENTONITE MIXTURES (AMBROSE AND LOOMIS)

Mud (per cent by weight	Weight per cu. ft.
4.05 bentonite	63.9
5.07 bentonite	64.2
5.84 bentonite	64.6

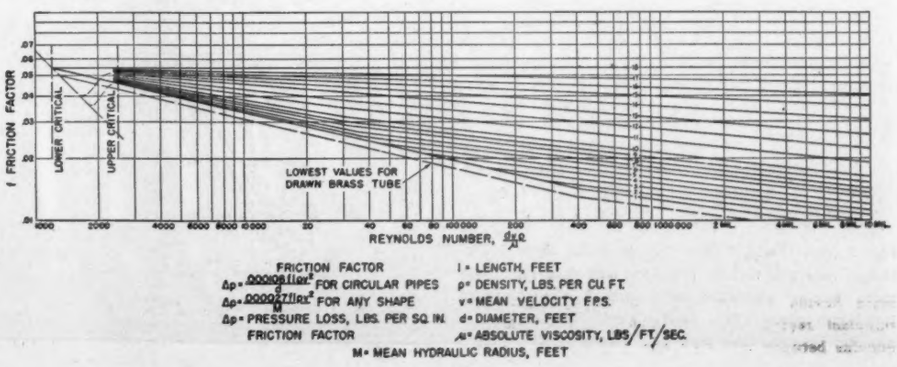

f FRICTION FACTOR
LOWER CRITICAL
UPPER CRITICAL
LOWEST VALUES FOR DRAWN BRASS TUBE
REYNOLDS NUMBER, DVρ/μ
FRICTION FACTOR
Δp = PRESSURE LOSS, LBS. PER SQ. IN.
l = LENGTH, FEET
ρ = DENSITY, LBS. PER CU. FT.
v = MEAN VELOCITY F.P.S.
d = DIAMETER, FEET
μ = ABSOLUTE VISCOSITY, LBS/FT/SEC.
M = MEAN HYDRAULIC RADIUS, FEET

TABLE 3—SELECTED LOCATION OF *f* BY ROUGHNESS RELATION

Curve	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Roughness (per cent)	0.2	0.45	0.81	1.35	2.1	3.0	3.8	4.8	6.0	7.2	10.5	14.5	19.0	24.0	28.0	31.5	34.0	37.5
1. Drawn tubing—brass, tin, lead, glass (inches)	35 up	...	...	...	...	...	...	...	...	...	...	...	...	0.125	...	...	...	0.0625
2. Clean steel—wrought iron	72	48-66	14-42	6-12	4-5	2-3	1½	1-1¼	¾	½	⅜	¼	⅛	...	...	...	...	...
3. Clean—galvanized	...	...	30	10-24	6-8	3-5	2¼	1½-2	1¼	1	¾	½	...	⅜	...	¼	...	⅛
4. Best cast iron—cement, light-riveted sheet ducts	...	...	48-96	20-48	12-16	5-10	3-4	2-2½	1½	1¼	1	...	...	...	...	...	...	...
5. Average cast iron—rough-formed concrete	...	...	96	42-96	24-36	10-20	6-8	4-5	3	...	...	...	...	...	...	...	...	...
6. First-class brick—heavy-riveted, spiral-riveted	...	...	220	84-204	47-72	20-42	16-18	10-14	8	5	4	3	...	...	...	...	...	...

Drawn tubing—actual inside diameter. Pipe—nominal size, standard weight.

and Loomis bentonite mixtures.[3]

The essential properties are given in Table 2.

In the lower part of Fig. 4 the two higher Ambrose and Loomis muds are plotted (dash line to show the similarity in slopes of viscosity).

It is apparent that these muds all behave much alike, the variation of apparent viscosity is nearly inversely as velocity, until nearly up to the turbulent breakover; with the heavier muds, this inverse relation holds right up to breakover. For a given makeup of clay, such as five of Gregory's six series, likewise Ambrose and Loomis, the viscosity in the viscous region is approximately proportional to the fourth power of the percentage of clay by weight.

Examining Formula 1 and 2 for cuttings, it is easily apparent that density of the mud is of value in both viscous and turbulent regions, but viscosity is only of value in the viscous region.

Examining Formulas 5 and 7 for the flow resistance indicates that high viscosity is objectionable in the viscous region, the pressure loss being directly proportional. In the turbulent region, viscosity is not so important; it appears only in the friction factor f, and there only to about the 0.15 power for steel pipes of the size used in wells, and down to zero for fully rough passages such as open hole.

For an example, let us take two typical muds whose viscosities are given in Fig. 6.

	Lb. per gal.	Lb. per ft.	Solids (per cent by weight)
No. 1	10.6	79.5	35.0
No. 2	9.5	71.0	20.0

All of the conduits in the entire circuit must be figured to get total pressure on the pumps, drill hose, drill pipe (including additional losses due to joints, elbows, return passage between drill pipe and hole, and the tool); 90° elbows may be taken at 0.5 velocity head loss each, 45° elbows at 0.2 velocity head.

Velocity head is: $\Delta p = 0.000108\, \rho v^2$.

The friction factor f can be obtained from Fig. 7 and Table 3, reproduced from the writer's paper before the American Society of Mechanical Engineers in 1933. The Reynolds number R is $\frac{dv\rho}{\mu}$, all quantities in English units.

Fig. 8 shows drilling-hose resistance;

Fig. 9—drill-pipe resistance;

Fig. 10—combinations of 3½-in. and 4½-in. drill pipe in 7, 10, and 18-in. hole;

Fig. 11—bit resistance;

Fig. 12—total pressure loss for a 4,000-ft. setup.

Lifting Cuttings

Referring to Formulas 1, 2, 3 and 4, and computing for the two selected muds, we get the values given in Tables 4, 5, and 6.

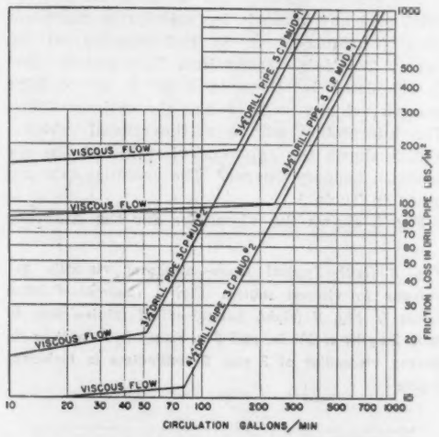
The maximum size of cutting is not likely to exceed 0.5 in. in diameter, as the rock-bit tooth space will not produce a much greater size; and in all cases a larger size must be crushed to pass the bits. To give an idea of the velocities ordinarily occurring, Table 7 shows the velocities for several combinations at 300 gal. per minute.

Fortunately for ease of lifting, ordinarily we do not encounter round cutting much larger than 0.063 in. in diameter (sand), as nearly all the chips cut from consolidated formations are flattish in shape.

Considering the values, we can see readily that 0.5-in. flat cuttings and smaller would rise with No. 1 mud in the 18-in. hole, but not with No. 2; 0.25-in. chips and smaller would rise with No. 2 mud; larger ones must be ground up before the material will rise. It is clear from the difference in slip rates that classification of sizes occurs in the hole, tending obviously to raise the percentage of large cuttings in the stream. Then it is clear that in entering a larger section of hole, say from the 10-in. to the 18-in., some of the larger cuttings lifted by higher velocity in the 10-in. hole may hang back and accumulate. This condition might account for some cases of stuck drill pipe.

If there are any caved places in the hole, these are where such accumulations might occur and

(Continued on Page 146)


VISCOUS FLOW
VISCOUS FLOW
VISCOUS FLOW
VISCOUS FLOW
3½" DRILL PIPE 5 C.P. MUD #2
3½" DRILL PIPE 5 C.P. MUD #1
4½" DRILL PIPE 5 C.P. MUD #1
3½" DRILL PIPE 3 C.P. MUD #2
4½" DRILL PIPE 3 C.P. MUD #2
FRICTION LOSS IN DRILL PIPE LBS./IN²
CIRCULATION GALLONS/MIN.

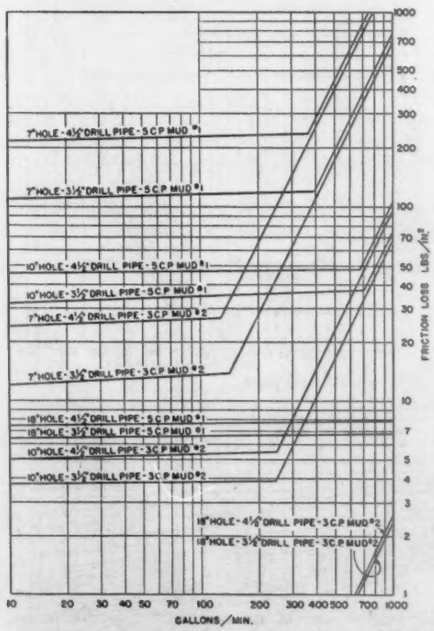
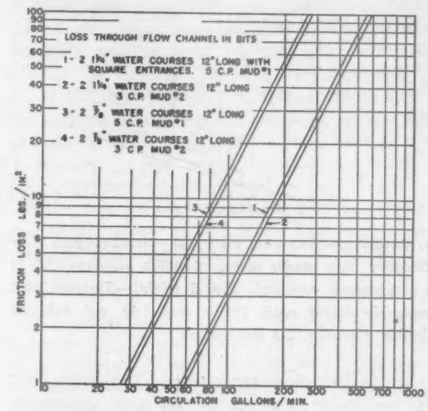

7" HOLE - 4½" DRILL PIPE - 5 C.P. MUD #1
7" HOLE - 3½" DRILL PIPE - 5 C.P. MUD #1
10" HOLE - 4½" DRILL PIPE - 5 C.P. MUD #1
10" HOLE - 3½" DRILL PIPE - 5 C.P. MUD #1
7" HOLE - 4½" DRILL PIPE - 3 C.P. MUD #2
7" HOLE - 3½" DRILL PIPE - 3 C.P. MUD #2
18" HOLE - 4½" DRILL PIPE - 5 C.P. MUD #1
18" HOLE - 3½" DRILL PIPE - 5 C.P. MUD #1
10" HOLE - 4½" DRILL PIPE - 3 C.P. MUD #2
10" HOLE - 3½" DRILL PIPE - 3 C.P. MUD #2
18" HOLE - 4½" DRILL PIPE - 3 C.P. MUD #2
18" HOLE - 3½" DRILL PIPE - 3 C.P. MUD #2
FRICTION LOSS LBS./IN²
GALLONS/MIN.

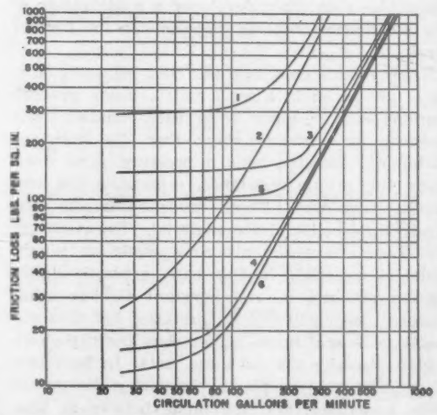
Fig. 9 (top)—Fluid friction loss in 4,000 ft. of 3½-in. (2.9-in. I.d.) and 4½-in. (3.958-in. I.d.) drill pipe with muds having viscosities of 3 and 5 centipoises in turbulent region. Fig. 10 (bottom)—Friction loss in annulus between drill pipe and hole at 4,000-ft. depth

TABLE 4—VISCOUS SLIP, MUD NO. 1

Mud velocity (ft. per sec.)	Diameter of cuttings (inches) 0.50	0.25	0.125	0.063	0.031
Round Particles					
0.1	0.07	0.018	0.004	0.001	0.000
0.3	0.21	0.054	0.013	0.003	0.000
0.5	0.35	0.090	0.022	0.006	0.015
1.0	0.70	0.180	0.044	0.011	0.003
2.0	1.39	0.350	0.086	0.022	0.006
3.0	*T*	0.510	0.130	0.032	0.008
4.0	*T*	0.670	0.170	0.042	0.011
6.0	*T*	0.960	0.240	0.060	0.015
8.0	*T*	1.210	0.300	0.075	0.019
10.0	*T*	*T*	0.360	0.090	0.023
Flat Particles					
0.1	0.027	0.007	0.002	0.000	0.000
0.3	0.081	0.021	0.005	0.000	0.000
0.5	0.135	0.035	0.085	0.002	0.000
1.0	0.270	0.070	0.017	0.004	0.001
2.0	0.540	0.140	0.033	0.008	0.002
3.0	*T*	0.200	0.048	0.012	0.003
4.0	*T*	0.270	0.065	0.016	0.004
6.0	*T*	0.380	0.094	0.023	0.006
8.0	*T*	0.470	0.117	0.029	0.007
10.0	*T*	*T*	0.139	0.035	0.009

T indicates turbulent fall, see Table 6.


LOSS THROUGH FLOW CHANNEL IN BITS
1- 2 1¾" WATER COURSES 12" LONG WITH SQUARE ENTRANCES. 5 C.P. MUD #1
2- 2 1¾" WATER COURSES 12" LONG 3 C.P. MUD #2
3- 2 ⅞" WATER COURSES 12" LONG 5 C.P. MUD #1
4- 2 ⅞" WATER COURSES 12" LONG 3 C.P. MUD #2
FRICTION LOSS LBS./IN²
CIRCULATION GALLONS/MIN.



Total pressure loss with various combinations of hole, drill pipe, hose and bit flow channel sizes: (1) 2½-in. hose, 3½-in. drill pipe, 7-in. hole, two ⅞-in. diameter drill passages, 5 C.P. mud No. 1. (2) Same as No. 1 except 3 C.P. mud No. 2. (3) 3-in. hose, 4½-in. drill pipe, 10-in. hole, two 1¼-in. diameter drill passages, 5 C.P. mud No. 1. (4) Same as No. 3 except 3 C.P. Mud, No. 2. (5) 3-in. hose, 4½-in. drill pipe, 18-in. hole, two 1¼-in. diameter drill passages, 5 C.P. mud No. 1. (6) Same as No. 5 except 3 C.P. mud No. 2.

Fig. 11 (top)—Bit resistance. Fig. 12 (bottom)—Total pressure loss for 4,000-ft. setup

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Cathodic Protection of Open-Tank Condensers

By N. A. MILLER
Universal Oil Products Co., Chicago

A.P.I.

Cathodic protection as a means of combating corrosion is not new, but a comparatively small amount of data is available on its application to open-tank condensers. The same general principles of cathodic protection which have been applied widely and successfully to pipe lines apply equally well to the protection of open-tank condensers.

The performance records of installations in open-tank condensers are meager, but they all indicate positive benefits. The installation and operating costs are relatively low in comparison with the possible savings through reduction of corrosion, particularly in severe cases. There is need, however, for further development work to determine the economic justification for cathodic protection in cases of moderate corrosion.

Paper was presented before the group session on refining, at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

CATHODIC protection as a means of combating corrosion of metallic structures in contact with water has been familiar to us for a long time. It has been applied for years to ships' bottoms, submerged and underground cables and pipe lines, and in a few instances to shell-and-tube type condensers or coolers. Some of the installations have used zinc plates as anodes, depending upon galvanic action between the anodes and the structure to be protected, which structure acts as a cathode. The remainder have used external sources of potentials to produce the protective current.

Cathodic protection of some types of equipment, notably pipe lines, has produced incontestable beneficial results, and a good deal of valuable data has been recorded. So far, however, we have not been able to discover any published information of a strictly technical nature on cathodic protection of open-tank condensers. Several people have made successful installations, but apparently no one has attempted to collect and coordinate the data available from these various sources.

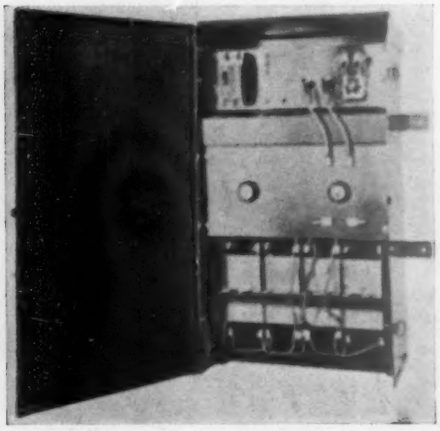

Fig. 1—Photograph of typical copper-oxide rectifier in weatherproof housing

Undoubtedly other individuals aside from those with whose work the author is familiar also have made studies of this subject, and possibly have made actual installations. It is hoped that this paper will bring comments from them, which will constitute valuable additions to the data which we now have.

Present Status of Cathodic Protection as Applied to Open-Tank Condensers

With this introduction we should like to review the present status of cathodic protection of open-tank condensers by citing the service record of the installations of which we have records, as follows:

1. Naph-Sol Refining Co. at Muskegon, Mich., has had an installation in service in its 6,000-sq. ft. distillate condenser box since late 1938. Prior to that date corrosion of the coils had been severe, necessitating replacement of the entire coils twice, at intervals of approximately 8 to 9 months, although during this period a set of zinc plates provided a galvanic-cell protection which was of only small benefit. The cathodic-protection system installed in 1938 involved the use of a small motor generator delivering about 10 amp. The present set of coils in the tank was installed about 3 months prior to the placing in operation of the motor generator, and these coils are still in good condition after almost 2½ years of service.

Two additional coils, however, were installed several months ago at either end of the box, and these have corroded. Therefore, within the past few weeks, the anodes have been replaced by others of larger area and better distribution, and the intention is to purchase a rectifier of larger current capacity than the present motor generator.

2. Richfield Oil Corp. at Wilmington, Calif., has had several installations operating successfully for about 2 years on its new 50,000-bbl. plant. Walton C. Poole, of the Sinclair Refining Co., at East Chicago, Ind., has furnished us with the following data regarding these installations.

Corrosion developed very rapidly when this plant was started up, and leaks developed within 3 months. Cathodic-protection equipment then was installed on all the condenser and cooler boxes of this plant, and no further trouble from corrosion has been encountered.

The benefits of cathodic protection have been confirmed here through the installation of test samples. The test samples consist of small plates of the same material as the condenser tubes. They are located in the condenser in pairs, one of each pair being connected solidly to the tube so as to receive the benefit of the protection, and the other being insulated from the tube so as to be without protection. Considerably less corrosion has occurred on the protected samples than on the insulated samples.

It was observed further that, as a result of the cathodic protection, the precipitate deposited from the water onto the condenser tubes was of a soft nature, and could be hosed off when the plant was shut down and the tank drained; whereas, without protection, the deposit was in the form of a hard scale. This feature was well demonstrated on one occasion when one of these units was taken out of service because of a short circuit which developed in it, and the plant run was completed without this unit in operation. When the plant next was brought down for cleaning, this box was found to be badly scaled up.

Fig. 2 (left)—Photograph of installation of anodes at Kendall Refining Co. Fig. 3 (right)—Another view of installation of anodes at Kendall Refining Co.

It was found also that cathodic protection appeared to result in better heat transmission through elimination of hard-scale formation on the condenser tubes.

3. Sinclair Refining Co. at East Chicago, Ind., has installed an experimental unit constructed similar to those in successful operation at the Richfield plant. The total area of cathodes in this condenser, i.e., the tank and coils combined, is approximately 25,000 sq. ft. The source of cur-

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rent is a General Electric rectifier rated at 10.5 volts, 78 amp. (see Fig. 1). The rectifier is mounted directly on the side of the condenser.

This unit has been in operation only since early March, not long enough to furnish any performance data.

4. Kendall Refining Co. at Bradford, Pa., has installed a set of anodes in its distillate condenser box, of which the total area of submerged surface is approximately 8,600 sq. ft. (see Figs. 2 and 3).

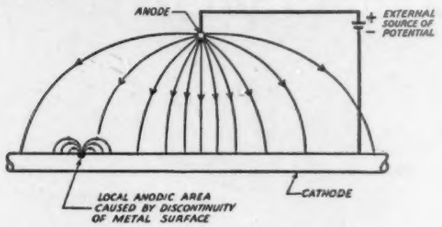

Fig. 4—Action of galvanic currents and distribution of protective currents

At the time of this writing its rectifier was on order but not delivered and, therefore, no operating data are yet available from this unit.

We should like to quote from a letter which we received about a year ago from Kendall setting forth the reasons which prompted them to make this installation:

"We figure that our condenser-coil cost, for 1931 up to 1939, was approximately $10,500, representing the cost of the original coils and the replacement of the top section on two different occasions. Then in 1939 a complete replacement was made, the cost of which was approximately $7,200. You can see from this that any protection which will decrease this cost which is around $1,000 per year, would be most desirable."

The foregoing installations when totaled do not constitute a large record. The interesting feature, however, is that all of these records indicate positive beneficial results. Also, the installations were made in each case by individuals acting independently, and without previous experience in such work.

Summary of the Art and Economics

Having presented this brief summary of the status of the art, we should like to proceed with a brief description of the underlying principles, the apparatus required, and the economics involved.

Theory.

The theory of cathodic protection probably is understood generally, but the author would like to review it briefly as he believes that doing so will clarify subsequent discussions.

All corrosion of metals in contact with water or moist earth takes place by just one means—electrolytic action. This action may take place through: (1) dissimilarity of two metals in electrical contact in an electrolyte; (2) two metals in different electrolytes; (3) like metals in two concentrations of the same electrolyte; and (4) the same metal in different electrolytes. We are concerned primarily, in so far as this discussion is concerned, with the first of these—in which case the dissimilarity in the metal may be caused by impurities; mill scale; or differences in composition, stress, or temperature.

This action results from the fact that any metal when submerged in an electrolyte assumes a negative potential with respect to the electrolyte. This potential is called "solution" potential, and each kind of metal has a definite and constant solution potential. If two metals with different solution potentials are placed in contact with an electrolyte and also are connected through a metallic circuit, we have an electric battery cell, and current will flow impelled by a voltage equal to the difference between the solution potentials of the two metals. The current flow moves through the electrolyte from the metal with the greater solution pressure, which is the anode, to the metal with the lesser solution pressure, which is the cathode. This current flow is the movement of acid ions through the electrolyte to the anode—which ions consume the anode at a definite rate—and movement of hydrogen ions to the cathode—where the hydrogen precipitates out of the electrolyte.

The result of this hydrogen in quiet water is to provide an insulating film around the cathode, tending to prevent the further flow of current and the further corrosion of the anode. This condition is called polarization. Any factor which tends to depolarize the cathode, however, thereby will restore the current and corrosion of the anode. Such factors may be the presence of dissolved oxygen which combines chemically with the hydrogen and removes it, or turbulence which washes the hydrogen away, or increased temperature which generally accelerates chemical activity, or increased concentration of acids, alkalies, or other impurities in the electrolyte which increases

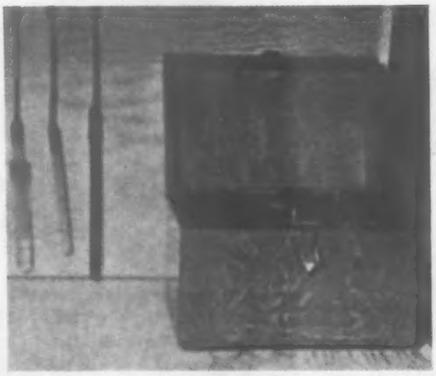

Fig. 5—Portable potentiometer, calomel cell and test electrode for measuring cathodic potentials

conductivity of the electrolyte and, hence, the current flow.

Regardless of which of the above factors is predominant, corrosion actually takes place when current flows from the metal into the electrolyte and the metal is anodic. When this current flows back into the metal, the reverse action takes place, and metallic or hydrogen ions in solution tend to precipitate out upon the metal, which at this point is cathodic.

The purpose of cathodic protection is to provide an artificial current which overcomes the small circulating current, reducing or extinguishing the anodic areas and rendering most or all of the metallic areas cathodic (see Fig. 4). This can be done by providing artificial anodes consisting of a metal whose solution potential is greater than that of the metal to be protected, such as zinc against iron. The other method is to introduce an external source of direct current between anodes of any metals and the structure to be protected by rendering the structure (in this instance the condenser coils) cathodic. The latter method is the one most generally employed now because of the larger current made available thereby.

Apparatus required.

The installation consists of two items: the anodes and the source of direct current.

The anodes generally consist of a set of steel plates submerged vertically in the condenser tanks from the surface down to close to the bottom, and they are spaced to give a reasonably good current distribution throughout the box. In locations wherein it is difficult to renew steel plates, it might be more economical to use carbon plates or carbon rods. The National Carbon Co. has developed a means of sealing the connections to these carbon anodes for cathodic work, which method prevents the lead wires from decomposing. The coils are hung from cables or rods fastened in turn to a horizontal structural beam or pipe which, in turn, is suspended from an insulating support. Positive and negative electrical buses are run around the outside of the tank, the positive bus being connected at various points to the horizontal beam or pipe supporting the anodes, and the negative bus being soldered at various points to the tank with taps to the inlet and outlet headers of the coils in the tanks. All electrical connections are soldered solidly or welded.

The source of direct current may be either a motor generator or a rectifier of the copper-oxide, selenium, or tube type. The rectifier has the advantage over a motor generator set in that it is nonsparking in operation and, therefore, is more suitable for operation within the refinery process area. Rectifiers of both the copper oxide and selenium-cell type have been developed for outdoor use in connection with pipe lines; have been developed with weatherproof housing; and are generally of rugged construction for operation without attention for long periods in remote locations. The copper-oxide type has been used more generally. The copper-oxide type is offered by both the General Electric and Westinghouse companies, and the selenium type by Electrical Facilities, Inc. All types are provided complete with main breakers, voltmeters, ammeters, and tap changing devices for adjustment of voltage and current. They are provided also with a fan to provide increased capacity and a wind relay located in front of the fan, which shuts the unit down should the fan fail.

Points of design.

Successful operation of cathodic-protection units appears to be largely dependent upon the proper spacing of anodes so as to provide uniform current over the entire area of the condenser, which, in turn, will prevent areas remote from the anodes from being underprotected and areas close to the anodes from receiving wasteful amounts of current.

(Continued on Page 75)

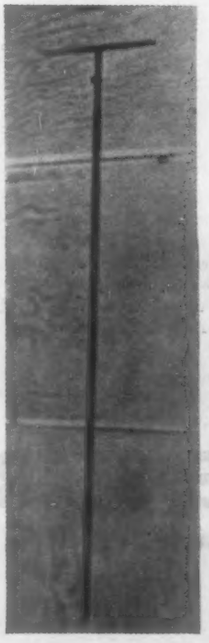

Fig. 6 (left)—Exploring electrode for measuring cathodic potentials. Fig. 7 (below)—Exploring electrode—closeup view of tip

The Economics of Flue-Gas Recirculation and Economizers

In Fired Tubular Heaters For Oil Refineries

By C. C. NELSON
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A.P.I.

A series of test runs made in 1926 upon a cracking-coil furnace, which had been equipped with a flue-gas recirculation system, indicated that this type of equipment is uneconomical for ordinary petroleum-refinery heaters. As a corrective procedure for reducing excessive radiant-heat inputs in an existing setting, this operation appeared to be more economical than the use of high percentages of excess air, but even in these cases it is preferable to revise the furnace design rather than use recirculation.

Between 1926 and 1930, a number of air preheaters were installed on cracking coils and pipe stills in several domestic refineries. An economic study based upon a series of test runs on three of these cracking-coil installations indicated that a maximum gross annual return of 40 per cent, excluding depreciation and maintenance charges, could be obtained, based upon 1926 prices. Based upon present construction costs and fuel prices, the estimated gross annual return on an equivalent installation would be reduced to 23.5 per cent for a refinery located in the New York area, or to 15.5 per cent for one located in the southern United States where lower fuel prices prevail. Even the 40 per cent return was found to be inadequate to pay the excessively high maintenance and repair costs encountered, which were due mainly to fouling and corrosion. This, in turn, probably was caused by the poor-quality fuels usually burned at these units, and which must be utilized in normal refinery operation.

Paper was presented before the group session on refining, at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

FLUE-GAS recirculation and air-preheater systems were used fairly extensively in the petroleum industry a few years ago. At the present time, however, there appears to be a general trend away from the use of these types of equipment. In this paper it is proposed to examine the economic factors underlying this trend. Performance tests which were run on a number of plant installations from 10 to 15 years ago have been restudied on the basis of present-day costs and refinery practice to determine to what extent the conclusions reached at that time must be modified when modern installations are considered.

Flue-Gas Recirculation

The use of flue-gas recirculation in petroleum heaters is the subject of several patents by Bell.[1] It is carried out in furnaces of various common designs. All involve some means of returning a portion of the flue gas from the outlet of the furnace to some intermediate point, usually to a point just beyond the combustion zone. The primary purpose of this is to reduce the temperature in the radiant section of the furnace, thereby moderating the radiant-heat intensity. As a result of the increased quantity of flue gas, it is possible to obtain higher heat-transfer coefficients in the convection section of a given furnace; and, in addition, more uniform heat densities may be obtained throughout the entire convection section. Some designs for furnaces employing flue-gas recirculation go so far as to eliminate completely the radiant-section tubes and accomplish all of the oil heating in convection tubes.

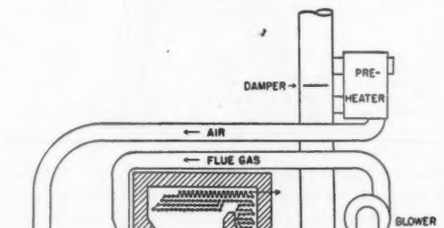


Fig. 1—Furnace employing both air-preheater and flue-gas recirculation system

The experience of the Standard Oil Co. of New Jersey with flue-gas recirculation dates from about 15 years ago. With the types of heaters then in use, without flue-gas recirculation, considerable difficulty was experienced due to excessively high radiant-heat inputs, resulting in high tube-metal temperatures and the danger of tube failures. It was common practice to alleviate this condition by firing with high percentages of excess air, which resulted in low heat efficiencies. Under these conditions, the adoption of flue-gas recirculation as a substitute for operation with high percentages of excess air indicated a very considerable fuel saving. Accordingly, a test installation was made on a cracking coil in one of the refineries.

Several test runs were carried out with an existing cracking furnace (shown in Fig. 1) which had been equipped with both a flue-gas recirculation system and an air preheater. The equipment was arranged so that the two systems could be used separately or in combination. A summary of the results obtained is given in Table 1.

The installation cost of the flue-gas and air-preheat equipment on this unit was considerably higher than originally expected. This was due in part to the use of an existing furnace which had not been designed originally for this type of equipment and, also, due to the requirement of having the preheater circuit entirely separate from the flue-gas recirculation circuits so that both could be operated singly or simultaneously.

The fuel savings have been evaluated on three different bases: (*a*) Using a fuel-oil price of $1.68 per barrel, which was used in the original economic study in 1926; (*b*) using $1.20 per barrel as a typical current New York area price; (*c*) using 80 cents per barrel as a typical current price in the southern part of the United States. It is apparent that the gross annual return on this equipment is much lower at present fuel prices than it was in 1926, assuming the same installation cost. Even at the high fuel value, however, it is unlikely that the indicated 43 per cent gross annual return is sufficient to meet depreciation, maintenance, and power costs. The general subject of maintenance and repairs will be considered later in connection with air preheaters. No figures are available on the actual maintenance cost of this flue-gas recirculating equipment, because the furnace setting was rebuilt in the following year and the recirculation system was not reinstalled.

Considerable difficulty was encountered in the

TABLE 1—FLUE-GAS RECIRCULATION TESTS

Operation	Normal		With flue-gas recirculation		Flue-gas recirculation and air preheat	
Run	1	2	3	4	5	6
Total flue gas at furnace outlet, pounds per hour	22,100	19,400	24,100	24,000	26,800	26,900
Recirculated flue gas, pounds per hour	0	0	10,000	10,000	12,000	12,000
Excess air at furnace outlet, per cent	83	71.5	20	23	12	13
Flue-gas temperature leaving furnace, deg. F.	833	658	794	777	918	769
Flue-gas temperature in stack, deg. F.	.....	.....	740	715	281	319
Fuel oil required for 10,000,000 B.t.u. heat pickup, gallons per hour	113		99.5		86	
Fuel saving, gallons per hour	...		13.5		27	
Installation cost,* dollars	...		9,000		20,000	
Value of fuel saving, dollars per year:						
(*a*) At $1.68 per barrel, New York, 1926	...		3,900		7,800	
(*b*) At $1.20 per barrel, New York, 1941	...		2,800		5,600	
(*c*) At 80 cents per barrel, southern U. S., 1941	...		1,850		3,700	
Annual return (excluding depreciation, maintenance, and power cost),† per cent:						
(*a*) Based on fuel costs given above	...		43		39	
(*b*) Based on fuel costs given above	...		31		28	
(*c*) Based on fuel costs given above	...		20.5		18.5	

*This was actual cost of complete installation at existing furnace. This was considerably higher than estimated originally.

†Power consumption was not measured on these tests. Preheater fan had a 10-hp. motor drive. Recirculating fan was driven by a 30-hp. steam engine.

operation of the furnace when an attempt was made to fire oil fuel, due to the fact that combustion was not complete at the point of introduction of the recirculated flue gas. It was necessary finally to go to gas firing in order to get good combustion conditions. This, however, is a matter of furnace design and burner selection, and has no direct bearing on the merits of flue-gas recirculation as such.

Flue-Gas Recirculation vs. Furnace Design

The general conclusion which was reached from the foregoing experience was that the use of flue-gas recirculation as a means of moderating heat inputs was not economically desirable. Subsequent experience has shown that substantially the same results can be obtained by modifying the furnace design so that excessive radiant-heat inputs are not encountered even at low percentages of excess air. Furthermore, the improvement in burner design in recent years has made possible also the construction of furnaces with fairly uniform radiant-section heat distribution.

Once satisfactory furnaces are developed which operate with low percentages of excess air, there is little further advantage in the use of flue-gas recirculation. As pointed out by W. L. Nelson,[2] it is theoretically possible to decrease the required tube surface slightly by the use of flue-gas recirculation, but it is concluded that the decrease is not sufficient to pay for the installation of this equipment. The convection-section heat density can be made much more uniform, but the average remains about the same; and, so long as overheating does not occur in the region of maximum heat input, no particular gain is effected. It is realized, of course, that special cases may arise, when stocks are being handled at unusually high temperatures, when there might be merit in some sort of a recirculation system. For the general type of heaters now in common use in the petroleum refineries, however, it is concluded that flue-gas recirculation is economically undesirable.

Air Preheaters

Air preheaters are use widely on steam boilers and various other types of industrial furnaces. They still are used by a number of petroleum-refining companies, although their use has been discontinued by the refineries associated with the Standard Oil Co. (New Jersey). This discussion is limited to the economic aspects of the use of air preheaters, and does not consider the details of design and construction of this equipment, because these are fairly well standardized and adequately described in the literature.

The effect of air preheat upon the operation of the furnace is just the opposite from that of flue-gas recirculation, in that the use of preheated air increases the temperature of the combustion zone and causes a higher ratio of radiant to convection-section heat. This may necessitate increasing and rearranging the radiant-section surface, with a corresponding reduction in convection surface, in order to avoid overheating of the radiant-section tubes.

The economic desirability of air preheaters is determined in the usual manner for any particular case by balancing the value of the fuel saving against the depreciation, maintenance, and power cost of the installation. In addition, it is necessary to consider other alternative means of utilizing the same waste heat as a possible preferable solution to the problem.

It is the usual practice to design petroleum-refinery heaters for an exit flue-gas temperature which approaches the cold-oil inlet temperature by a predetermined number of degrees. This optimum temperature approach is computed for any given case by making an economic balance between the incremental cost of convection-section heating surface and the value of the additional heat recovered. For any particular design, therefore, increasing the cold-feed-stock inlet temperature raises the exit flue-gas temperature with a corresponding increase in the heat lost to the stack. At these higher flue-gas temperatures, reboilers, steam generators, and air preheaters come into consideration as possible methods of recovering some of this waste heat.

Considerably more experience has been had with air preheaters than with flue-gas recirculation systems. Preheaters have been used on a number of pipe stills, as well as cracking coils. An extensive series of preheater tests is summarized in Table 2. These tests were run between 1926 and 1930. In all cases, several tests were made both with and without using the air preheaters under as nearly comparable conditions of feed rate, operating temperatures, and pressures, etc., as it was possible to obtain experimentally. The fuel savings tabulated are those actually measured during the test runs. The fuel savings have been evaluated for the same three different fuel prices which were used for the flue-gas recirculation data of Table 1. In addition to the actual costs of the original air-preheater installations, figures are tabulated giving the estimated costs of modern air-preheater installations for equivalent service. The figures presented for the gross annual return at present fuel prices have been based upon these estimated present-day installation costs.

The tests tabulated under Series 1 in Table 2 were run on the same furnace that was used for the flue-gas recirculation tests (shown in Fig. 1). Series 2 tests were run on this setting a year later, after the furnace had been rebuilt. The Dutch oven was removed and the radiant section enlarged to permit the installation of an increased number of radiant tubes. The tests of Series 3 were run on a unit in a different refinery, which was very similar in furnace design to that of Series 1. This difference in furnace construction shows up in the operation of the furnaces in the percentage of excess air required. In Series 1 and 3, the percentages of excess air are high in order to prevent the overheating of the small number of radiant tubes. It is to be noted also that in these two cases it was necessary to use more excess air when the air preheater was used, which is in agreement with the general statement that air preheat increases the radiant-section heat intensity.

In Series 2, however, apparently overheating of the radiant tubes was not encountered, and the amount of excess air probably was limited by the combustion requirements. In this case, the use of preheated air actually reduced the excess air required for satisfactory operation. This test probably represents fairly closely the performance which reasonably might be expected from a modern unit today.

It is noted that, at the present price level, the use of air preheaters is much less attractive economically than at the time these installations were made originally. Even at the high fuel price, experience indicated that the 40 per cent gross annual return was insufficient to carry the high depreciation and maintenance costs on this equipment. It, therefore, was concluded that the use of air preheaters was economically undesirable for petroleum heaters of this type, and their use has been discontinued in these refineries.

In addition to these cracking-coil installations, air preheaters have been used on a number of pipe stills. No extensive comparative tests are available, but, in general, the costs and performance were very similar to those obtained on the cracking units. In this case, also, the use of preheaters was discontinued because of excessive cleaning and maintenance charges.

Maintenance and Repairs

Probably the most important, and at the same time the most difficult to evaluate, of the factors which determine the economic desirability of flue-gas recirculation and air-preheating equipment is that of maintenance. Unfortunately, the detailed record of maintenance and repair charges is no longer available for the units which have been described.

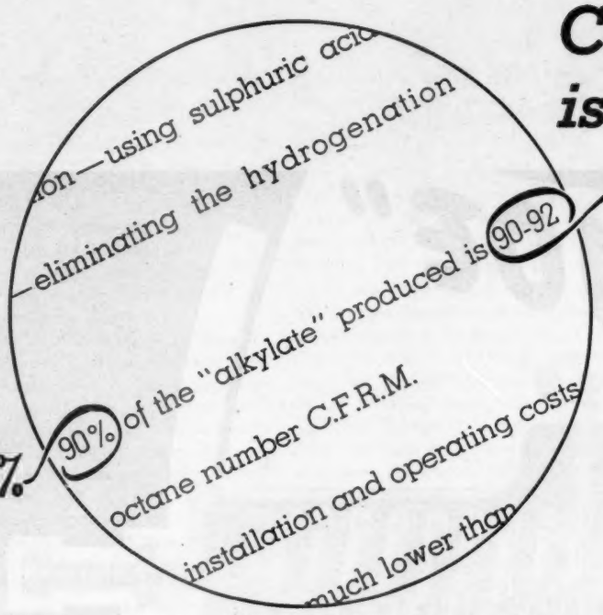
Many operating difficulties were encountered. One of the most serious was the depositing of a very adherent hard deposit of ash and tarry materials in the preheater tubes. This presented a very difficult and time-consuming cleaning problem, often resulting in mechanical damage to the equipment by the cleaning tools. In addition to this fouling problem, serious corrosion was encountered, especially if too low an exit temperature for the flue gas from the preheater was used, probably resulting in partial condensation of sulfur acids.

The foregoing difficulties, to a large extent, were probably due to the nature of the fuel which was burned in these units. It was the practice at that time, as it is today, to operate the refinery heaters—particularly on the pipe stills—on relatively poor-quality fuel, often containing considerable ash-forming sediment and usually fairly high in sulfur content. Gaseous fuels, in particular, which are used within the refineries are usually very high in sulfur content. This makes the problem of preheater maintenance much more serious than in commercial boilers, for example, for which specification fuels usually are prescribed. It is current practice in normal refinery operation to utilize the poorer-grade fuels, both

TABLE 2—AIR-PREHEATER TESTS—CRACKING-COIL FURNACES

	Series 1		Series 2		Series 3	
	Without Pre-heater*	With Pre-heater*	Without Pre-heater†	With Pre-heater†	Without Pre-heater‡	With Pre-heater‡
Pounds of flue gas per hour	21,000	20,500	20,400	16,300	34,400	41,000
Stack temperature, deg. F.	660	360	640	305	1,040	495
Excess air, per cent	70	90	33	23	70	130
Fuel fired, gallons per hour	105	92	127	109	153	137
Fuel saved by preheater, gallons per hour	...	13	...	18	...	16
Electric power used by preheater fan, kilowatts	...	7	...	6	...	29
Power cost, dollars per year:						
(a) At 0.01 cent per kilowatt-hour, 1926	500		430		2,100	
(b) At 0.004 cent per kilowatt-hour, 1941	200		175		833	
Original cost of preheater installation, dollars	11,000		12,000		10,750	
Estimated cost of equivalent modern installation, dollars	15,000		15,000		16,300	
Value of fuel saved, dollars per year:						
(a) At $1.68 per barrel, New York, 1926	3,750		5,200		4,600	
(b) At $1.20 per barrel, New York, 1941	2,700		3,700		3,300	
(c) At $0.80 per barrel, southern U. S., 1941	1,780		2,500		2,200	
Annual return (excluding depreciation and maintenance), per cent:						
(a) Original installation, 1926 costs	29.5		40		23	
(b) Modern installation, New York area	16.7		23.5		15.1	
(c) Modern installation, southern United States	10.5		15.5		8.4	

*Average of 6 test runs. †Average of 3 test runs. ‡Average of 2 test runs.



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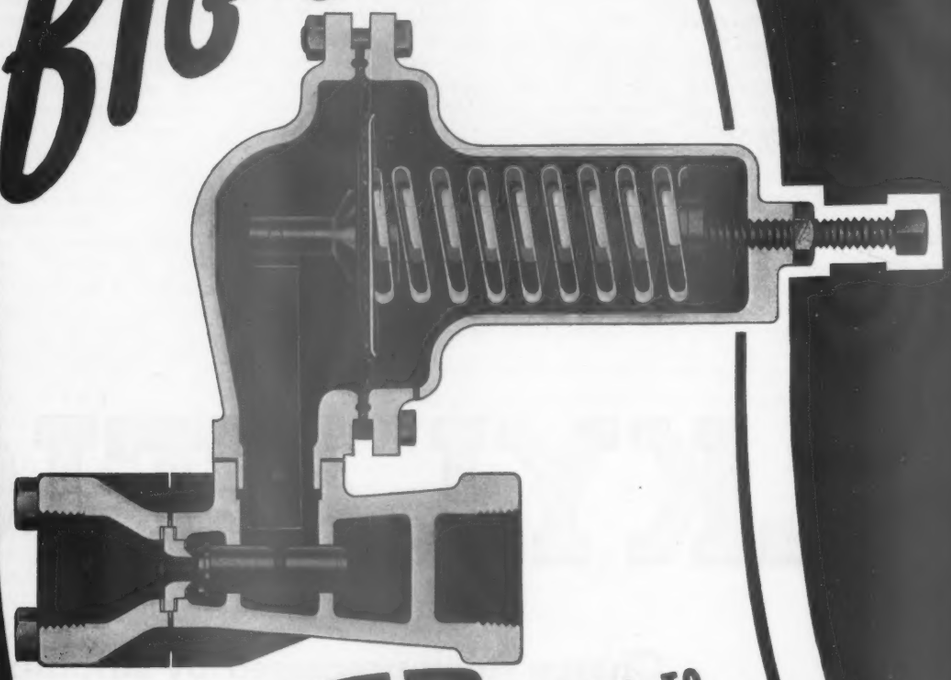

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gas and fuel oil, for firing refinery heaters, because there is usually no other equally economical outlet for these products.

As a result of the maintenance troubles, no new preheaters were installed, and the existing equipment was kept in operation only until major repairs were required. Their use then was discontinued permanently. The average service life of most of these units was probably not much more than 1 year.

Summary

Flue-gas recirculation appears to be economically attractive only in the case of existing heaters, which are subject to radiant-section overheating. In the case of new designs there is insufficient advantage to justify the installation of such a system, unless unusually high temperatures are anticipated, and even then there may be preferable alternatives.

Air preheaters, which have been shown to be effective in improving furnace efficiencies, are of doubtful practical utility in ordinary refinery heaters. Experience has indicated that the maintenance and repair costs outweigh the heat savings. At the present low fuel-oil prices, particularly in refineries in the southern part of the United States, the use of air preheaters is even less attractive than formerly.

Any particular installation, of course, must be examined in detail upon its own merit. The above generalizations were drawn from the operation of units which are believed to be fairly typical of those in general use in petroleum refineries. It is, however, entirely possible that differences in fuel quality and cost, along with differences in design and construction costs, may invalidate these conclusions for a particular set of conditions.

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●

Cathodic Protection of Open-Tank Condensers

(Continued from Page 68)

The current requirements are approximately 5 to 10 amp. per 1,000 sq. ft., this value depending in large part upon the degree of uniformity of current distribution. The current requirements are, in the last analysis, whatever is necessary to produce a certain minimum potential of cathodes relative to electrolyte at all points, and we shall go into this point a little further in a subsequent paragraph.

The anodes, in addition to being located properly, should be provided in sufficient quantity to maintain a low-circuit resistance in order to save power. Furthermore, the anodes will be consumed at the rate of approximately 20 lb. per amp. per year; and enough metal, therefore, should be provided so that the anodes will last a reasonable length of time.

The rectifier should be mounted as close as practical to the condenser in order to minimize line losses. A typical condenser requires about 6½ volts for a current of 100 amp. It was found that, unless the rectifier were placed within 100 ft. or less of the condenser, or the copper wires made very heavy, the losses in the lines between the rectifier and the condenser would equal the losses in the condenser itself.

Measurement of cathodic potentials.

As indicated previously, the true criterion of protection appears to be the existence of a definite minimum potential of cathodes with respect to electrolyte at all points. The value of this cathodic potential depends on the method used for measurement. There is considerable room for development in the methods of making these measurements. However, we should like to present a method of measurement which has been used by the Sinclair company, which method was passed along to us through the kindness of Mr. Poole of that company.

The principle of this method of measurement is to compare the potential between a test electrode, consisting of a short length of ½-in. pipe submerged a foot or so below the surface of the water, with the cathode—which, of course, consists of the coils and tank. Instead of measuring this potential directly, however, a calomel cell is used, which in itself is nonpolarizing (see Fig. 5). Readings are taken between the calomel cell and the test electrode, and also between the calomel cell and the cathode. The difference between the two readings, therefore, represents the difference between the potential of the test electrode and the potential of the cathode. To reduce the effects of polarization further a null-type potentiometer is used.

The potentiometer should read up to approximately 1.10 volts. A Leeds & Northrup potentiometer is suitable for this purpose. A Leeds & Northrup calomel cell also may be used, but the one developed by Sinclair appears to be much more satisfactory for field use; it is made as follows: A glass tube having an inside diameter of ¼ in. to ½ in. and a length of 6 in. to 8 in., open at one end and closed at the other, is provided with a platinum wire sealed into the closed end. A rubber-covered lead wire is soldered onto this platinum wire, and the connection covered with waterproof insulation. A few drops of mercury then are introduced to cover the end of the platinum wire. An electrolyte is prepared by dissolving 40 g. of potassium chloride in 100 ml. of hot water and then adding, with continued stirring, a few grains of mercurous chloride and, lastly, 3 g. of a good grade of chemical agar. This mixture then is poured into the tube and allowed to jell. A plug of paraffin then is placed in the open end of the tube to keep the jelly from drying out, this plug being removed or perforated when the calomel cell is to be used. In making the tests with the above equipment, both calomel cell and test electrode are submerged a few inches below the surface of the water, and both are located remote from each other, and remote from both anodes and cathodes. . . .

Another method of measuring electrolytic potentials which appears to have some advantages is to make use of the exploring electrode developed by G. I. Rhodes, vice president and chief engineer of Ford, Bacon & Davis, Inc., for use in surveys for cathodic protection of pipe lines (see Figs. 6 and 7). This consists of a button of definite area, made of the same steel as the cathode. This button is provided with an insulating tip ¼ in. long and with a ⅜-in. drill-rod handle about 4 ft. long insulated with bakelite tubing. This is operated by pressing the insulated tip against the cathode at various points, and measuring the potential between the button and the cathode by means of a null-type potentiometer.

The advantage of this method is that it can be used to explore various portions of the condenser and to locate points where protection is at a minimum.

A few simple experiments in our laboratories, using both the calomel cell and the exploring electrode, indicated a large disparity between the currents picked up by cathode at points close to, and remote from, the anodes—which was brought out by the exploring electrode, but not by the calomel cell and test electrode.

We should like to see more work done along this line to correlate readings obtained by the calomel cell and test electrode with those obtained by the exploring electrode. Ford, Bacon and Davis have stated that a negative potential of 250 mv. of cathode with respect to exploring electrodes in pipe-line service is a figure which represents good protection, and we should like also to determine if this figure is equally applicable to submerged coils in open-tank condensers.

Economics of cathodic protection of open-tank condensers.

The cost of the anodes and wiring for the installation at Kendall was estimated by the refiner to be approximately $650. The cost of a copper-oxide weatherproof rectifier rated at 10.5 volts, 78 amp., which is the unit we would recommend for this installation, would be approximately $350. The total cost of the unit, therefore, is approximately $1,000 which, when amortized in 5 years, gives an annual cost of $200. Added to this is the cost of energy which, at 1 cent per kilowatt-hour, will not exceed $60 per year. The total annual cost, therefore, is $260.

The annual cost of replacing coils at Kendall, as stated previously, has been approximately $1,000 per year. Therefore, if the cathodic-protection equipment is even moderately effective, it will pay out within a short time.

Conclusion

In conclusion, we should like to stress that a great deal has yet to be learned on the subject at hand. As stated previously, the operating records—at least those available to us to date—are meager; on the other hand, what information we do have indicates positive beneficial results.

We hope this discussion will serve to stimulate further investigation by others. The subject particularly needs data from installations in refineries under typical operating conditions.

The records we have all concern locations wherein corrosion was initially very bad. Additional data, however, are necessary to establish the economies involved for the border-line cases.

●

Universal Publishes New Edition of "Cracking Art"

A 618-page booklet carrying the title "The Cracking Art in 1939," has just been completed by the Universal Oil Products Co. This compilation is much larger than in any previous year and represents the contributions of seven literature researchers under the direction of Dr. Gustav Egloff, editor. The book traces developments in the refining industry to reveal the latter's transition from a peacetime industry to one capable of supplying huge quantities of war materials. In the year greatest impetus was given the synthesis of rubber substitutes, and the manufacture of plastics and aviation fuels. Butadiene, a source material for synthetic rubber was announced as an economic product from petroleum. Many polymerization plants, alkylation units and catalytic cracking processes of one kind or another were commercially developed for installation in that year.

The analysis of cracking installations for the year reveals trends in the choice of equipment and operations which, in turn, clearly indicates refiners have kept the need to produce gasolines of higher octane value constantly in the foreground. This is especially apparent when reviewing the long lists of polymerization plants installed, the substantial additions made to catalytic cracking capacity, the installation of major alkylation units, and the greatly extended use of copper chloride as a treating agent to conserve octane values.

Another important contribution contained in this book is the summary of patents which takes up 250 pages and reviews those issued in foreign countries as well as the United States. An elaborate reference and cross-indexing system help to make this book a most valuable contribution in the recording of modern refinery history.

Core-Analysis Interpretation

By NORRIS JOHNSTON
General Petroleum Corp., Los Angeles, Calif.

A.P.I.

Core analysis is an attempt to find the amount of space that is available for oil and gas in a subsurface reservoir, how much of this space actually is occupied with oil and gas and how much with water, how rapidly this oil and gas will be available, how much of it may be recoverable by various means, and how best to design those means of recovery. It will be evident to the critical reader that the broad use of core-analysis data involves many assumptions regarding fluid content and movement in a reservoir. A section has been added, therefore, discussing the present state of knowledge on which the necessary assumptions must be based.

Paper was presented before the group session, Division of Production, at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

IN order to find how much space there may be available for oil and gas in any reservoir rock, the "porosity" is measured. The porosity of a rock is the percentage of the bulk volume which is not filled by solid rock material. These interstices or pores have a great variety of sizes and shapes and degrees of interconnection. Some of them are not connected at all, but are sealed off hermetically, and represent "isolated porosity." The interconnected pores represent "effective porosity," because they may become effective in the recovery of oil and gas from the reservoir. The sum of effective and isolated porosity is equal to the porosity of the rock. Both effective and isolated pores may contain all three reservoir fluids—oil, gas, and water—but usually only those fluids in the effective pores should be considered as mobile or in any part recoverable.

Porosity of rock varies from nearly zero to about 60 per cent, the range for most oil reservoirs being from 10 to 40 per cent, with an average of 20 to 25 per cent in California. In California, the fraction of this porosity that may be considered as effective varies from almost 100 per cent to about 85 per cent for some highly cemented sands. The effective fraction averages almost 95 per cent, which makes it relatively unimportant whether effective or total porosity is measured on these particular sands. Shales frequently have porosities from 10 to 25 per cent, usually behaving like isolated porosity.

A laboratory technique has been adopted for measuring porosity of loose sands. A small amount (2 ml.) of kerosene is pipetted accurately into a 50 ml. graduate and about an equal volume of dry sand is added. This is tamped into a tight pack with a ⅜-in. flat-ended rod. The process is continued with about 1 ml. additions of sand and just enough kerosene to fill the sand pores (but no excess) until about 20 ml. of pack has been built. The bulk volume and the kerosene volume allow a direct calculation of total porosity. By comparison with effective porosity measured by a Kobe porosimeter, this method gives results which must be multiplied by 0.86 to give equivalent effective porosities of very soft but coherent sands.

Permeability (K).

In order to find how rapidly the valuable fluids in a given stratum of an oil or gas reservoir may become available, the permeability of the rock is measured. The permeability of a porous rock is a measure of its fluid-transmitting capacity.* Naturally only the effective pores will contribute to permeability. Nevertheless, permeability is not proportional to effective porosity by any means. A given porosity may be due to a few large pores, or to a great many smaller pores. Despite the fact that the coarse-pored sandstone does not have as many flow channels (interconnected pore spaces) as finer-pored sandstone, the flow capacity of a channel is so greatly dependent on its diameter that the coarser-pored stone, in general, will have the greater permeability. Coarser pores do not necessarily follow from coarser sand, as there may be sufficient fine sand in the coarse matrix to subdivide the pores, thus decreasing permeability. High permeability, in general, arises from sands which are poorly cemented and well graded (grains preponderantly of one size).

Permeability varies from practically zero for shales and tightly cemented rocks to several thousand millidarcys for the more closely graded coarse sands. California sand permeabilities have been measured as high as 25 darcys. Only one field, to the author's knowledge, averages higher than 1,000 md., and some average as low as 50 md. There are few large areas, or even individual sand bodies, that have very uniform permeability. The average permeability of Pliocene sands is considerably higher than that of Miocene sands. The extreme variation of permeability and its relative independence of porosity are shown by the following two examples from California core records: P = 57.5 per cent, K = 3 md.; P = 7.5 per cent, K = 210 md. The first of these cores was of diatomite, with an enormous number of extremely small pores. The second had relatively few coarse pores. A fracture will not increase porosity appreciably, but may increase permeability enormously. The lack of connection between permeability and porosity is not pointed out as a curiosity, but as an indication that the amount of space for oil and the speed of availability of such oil are not necessarily related properties of reservoir rocks, as might readily be assumed.

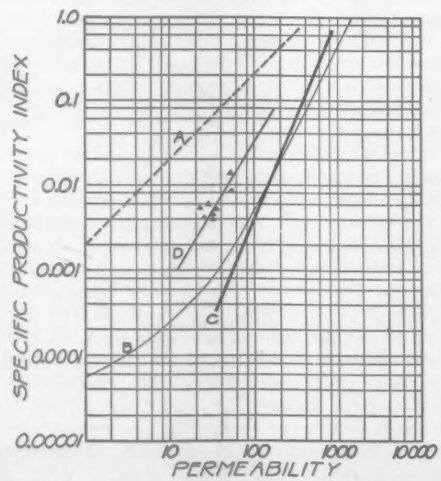


Fig. 1—Specific productivity index vs. average permeability

Porosity and permeability are almost independent physical properties of porous rocks, and are very difficult to estimate visually. Either can change with extreme rapidity along a vertical section, but, in general, varies less rapidly along the direction of bedding planes. In some uniform sands, correlations may be made between nearby wells by means of either porosity or permeability, the latter being preferred because of the much greater range of values encountered.

Permeability is generally greater the less consolidated the sand, and is probably greatest for entirely loose sands, although apparently no universally applicable method yet has been devised for measuring the permeability of entirely loose sand in the form in which it existed in the reservoir.† [1]

Permeability is generally measured with air, although dry oil should give the same value in a silica sandstone. The effective permeability to the flow of oil in the formation sands is never as great as the measured air permeability, because of the tightly bound layer of interstitial water surrounding each grain of silica, and thus lining each pore. This practically immobile water film simply has the effect of reducing the available cross-section of each flow channel and thus reducing the permeability to the flow of oil. Inasmuch as this film has a tendency to be of a thickness determined by intrinsic properties of water and silica, and not by pore size, it is obvious that the decrease in permeability caused by interstitial water should be more severe in sands with small pores, because the film of given thickness obstructs a greater percentage of the cross-sectional area of a small pore than of a large pore. Also tending in the same direction is the effect of interfacial tension between the water and oil, which causes a greater resistance to flow in the finer pores. Thus the disparity between air permeability and

*The unit of permeability is the darcy, defined as follows: A rock having a permeability of 1 darcy, under conditions of viscous flow, will pass 1 ml. per second of a fluid having a viscosity of 1 centipoise through a 1-sq. cm. cross-section when a pressure gradient of 1 atm. per cm. is applied. The more commonly used unit is the millidarcy, or 0.001 darcy. The abbreviation for millidarcy is "md.".

†A method has been devised for recompacting loose sand in such a way as to obtain reproducible permeabilities.

In this method, the sand is dampened with a very light hydrocarbon fraction, such as rubber solvent, tamped into a glass tube, dried by air flow and the permeability is measured. A 1¼-in. i.d. heavy-walled glass tube (sight glass) is fitted tightly with a cork carrying a glass tube. On this cork are placed several disks of coarse screen and, on top, a disk of screen fine enough to hold more than 80 per cent of the sand to be tested. The solvent dampened sand is then added at a rate of about ¼ to ½ in. deep at a time, and thoroughly tamped in place with a ⅜-in. round-ended rod. When a pack 6 in. deep has been made, all the loose sand and some of the upper compacted sand are cut away to make a flat upper surface of uniformly packed sand. Dry air then is flowed through this pack with appropriate end connections for the usual permeability tests. When steady state flow conditions are reached, the permeability is measured. A large number of very soft but consolidated sands of carefully measured permeability were crushed gently to avoid reducing natural grain size. These loose sands then were recompacted, and the permeability measured. The recompacted sands had the same permeability as the original at about 1,500 md.; but, for tighter sands, the recompaction was not able to duplicate the lower original permeabilities, so that at 4 md. original the recompacted sand had 220 md. permeability. This was an acceptable fact, inasmuch as the results could be duplicated. However, above 1,500 md. the recompacted sample was tighter than the original, so that original values of say 1,200 and 2,000 both gave a recompacted sand of 1,450 md., thus making interpretation difficult. As there is considerable demand for this type of measurement, and no published method is universally acceptable, further development should be undertaken.

effective permeability is greatest in tight sands.

Saturation (fluid content).

The oil and water content of the recovered core is measured in an attempt to determine whether the sand will be an oil producer or a wet sand, and also to help determine reserves and recovery. The liquid contents of the pores usually are expressed as a volume per cent of the pore space. The original formation liquid content is modified very greatly by two important processes before the core is recovered. First, inundation by drilling fluid seeping vertically downward from the bit—unimpeded by mud cake—washes the formation fluids out of the rock to be cored, to an extent dependent on permeability, rate of penetration, thickness of sand below nearest shale streak, and magnitude of the excess of mud pressure over the formation pressure. The core barrel then recovers the washed sandstone and brings it to the surface, from a region of high pressure to one of low pressure, so that any gas in solution in the remaining oil has an excellent chance to expand and expel both water and oil from the already washed core. Thus core oil and

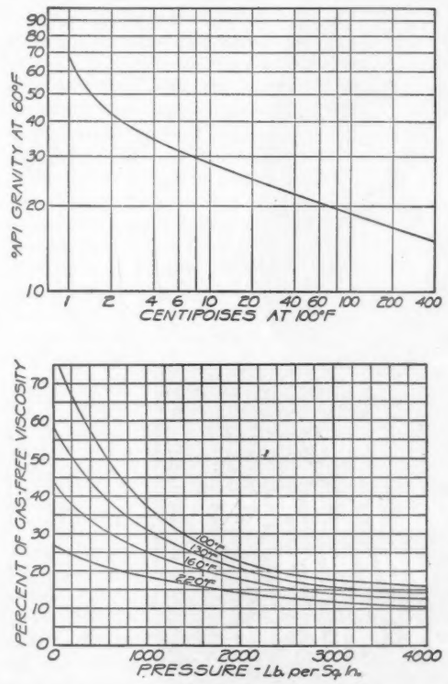


Fig. 2 (above)—Crude-oil viscosity vs. A.P.I. gravity. Fig. 3 (below)—Effect of temperature and saturation pressure on crude-oil viscosity (Sage and Lacey[5])

core water are radically different from the original formation liquid contents.

Several attempts have been made to recover the core, with all the liquid that was present in its pores at the bottom of the hole, by means of so-called "pressure core barrels." The Bureau of Mines-A.P.I. pressure core barrel[2] and the Carter pressure core barrel[3] have been successful in the Mid-Continent, and the Macready pressure core barrel‡ has shown considerable promise in California. Inasmuch as the pressure core barrel is unable to prevent drilling-mud contamination, it stands to solve only half the problem; and no successful method has yet been devised for avoiding bottom-hole contamination, although work on this phase of core analysis is in progress. Thus there is no means in sight to obtain a perfect sample of the oil-producing formation, and all information about the nature and behavior of reservoir sandstone must be obtained from imperfect samples by indirect methods.

‡Too new to be described in literature as yet.

The contamination problem is attacked with some success by coring with mud containing a "tracer" so that, if contamination cannot be avoided, it can be measured. This is difficult and expensive, but yields some very valuable results. This method is being supplanted to a considerable extent by coring with oil or an oil-base mud. The fluid contaminating the rock prior to its entering the core barrel then is oil instead of water. With due consideration of pressure gradients, flow rates, and time, it appears reasonable to assume that the contaminating oil merely displaces formation oil, and not interstitial water* so that the core contains its full quota of water on entering the barrel. Because expanding gas in an oil sand generally expels oil and not water,† it is fairly safe to assume that—even in the greatly accelerated gas-depletion process caused by bringing the core to the surface—the water is similarly unmolested, so that the core water is a true measure of interstitial water in a core taken with oil or oil-base-mud circulation. Thus, with the aid of reasonable assumptions, oil coring offers us possibly the best method of obtaining a sample of reservoir rock with a fair approximation to the correct water content. It is the author's opinion that this method gives a truer result than could any pressure core barrel used with ordinary mud, because water inundation usually changes both interstitial oil and water contents, whereas oil coring generally affects only the oil content. Use of a pressure core barrel with oil might afford the best answer of all.

An example of the changes which may occur in the fluid content of sand before it arrives at the core laboratory is shown in the following tabulation, for a hypothetical sand of 25 per cent porosity, and 250 md. permeability cored with an ordinary barrel:

Location of sample—	Ordinary mud			Oil-base mud		
	Oil	Water	Free gas	Oil	Water	Free gas
Formation, prior to coring	70	30	0	70	30	0
Core barrel, at bottom	25	75	0	70	30	0
Core barrel, at surface	12	72	16	55	30	15

Grain analysis.

A friable or loose sand may be analyzed as to grain-size distribution by ordinary test screens. Slot-size determination by grain analysis of a hard sand is rarely worthwhile; but if the analysis is desired, fresh-water soaking should procede crushing, to avoid an entirely artifical grain-size distribution. Studies have been made[4] to determine the size of opening, in a well screen, which is required to exclude a given type of soft or loose formation sand; and the grain analysis is required as a basis for this calculation. The author would like to emphasize A.P.I. standard practice of denoting size of slots in perforated pipe in "inches," rather than "mesh" (A.P.I. Std. No. 11-D, "Miscellaneous Pumping-Equipment Standards," p. 13, Sec. 9, Par. 9-*a*). Use of "mesh" is very misleading, as in screen mesh a larger number denotes a smaller hole, whereas in screen pipe is has been customary to call the "mesh" of a slot its size in thousandths of an inch.

Some attempts have been made to relate permeability of loose sand to grain-size distribution.[1] A formula was found satisfactory for the North Bradford sand; but it does not apply in California, and may not elsewhere. This lack of universal similarity of sands easily may be explained by differences in degree of rounding of the grains, and tightness of packing.

Chemical tests.

Chloride content of saline water from formation sands has been measured, and attempts have been made[5] to use this information in predicting wet sands and assisting with reserve and recovery estimates, by means of trying to ascertain formation fluid content from core saturation. This has never been highly satisfactory except in a few special cases, or locally.

Acid solubility of a core will tell whether any appreciable increase in permeability locally around the well bore will result from acid treatment. In California most of the sands are cemented by non-acid-soluble materials so that little help can be expected from acid. Some special acids may prove beneficial.

Core Analysis Interpretation Methods

Identification of sands.

A wet sand generally may be distinguished from an oil-producing sand by a careful study of several indices. If there is no oil saturation, the sand is either wet or a dry gas sand. If the former, the pores will be largely water-saturated, whereas a gas sand definitely is not saturated by core water. The amount of the saturation deficiency will depend on the amount of interstitial water and the amount and pressure of the gas in the formation, on the permeability, rate of drilling and excess mud pressure—or, in other words, on how much gas was present, and how much was washed out by drilling fluid.

An oil-producing sand may be described as one which, under formation conditions, had a sufficiently high oil-water ratio so that a small imposed pressure gradient would have caused the flow of oil rather than water. The determination of the critical ratio for distinguishing oil from wet sands, from data on cores as received at the surface, is dependent on indirect methods. The controlling factors are the probable formation-fluid content reconstructed from core-saturation data, the nature of both oil and formation rock, and the relation between effective permeabilities to oil and water under existing subsurface conditions. Reconstruction of formation-fluid content depends on knowledge concerning the amount of contamination, mean formation pressure and saturation pressure—which, in most cases, are known only approximately, if at all. The knowledge of relative effective permeabilities to oil and water is rather incomplete, as the high pressure and temperature tests of flow in consolidated sands are extremely difficult and expensive, and the range of variables has not been covered.

Thus distinguishing oil from water sands must rely on empirical rules. Observation has shown the oil-water (O/W) ratio in the core to be the first index to watch; but its interpretation must be tempered with notice of saturation and permeability, oil gravity, formation pressure, gas-oil ratio, closeness of a sand to an overlying shale, speed of drilling, mud pressure vs. static formation pressure, and possible typical characteristics of the sand being tested. For example, in one field, an O/W ratio of 0.05 means an oil-producing sand, where the saturation is below 90 per cent of pore space, permeability is above 100 md., oil gravity is above 30° A.P.I., formation pressure is

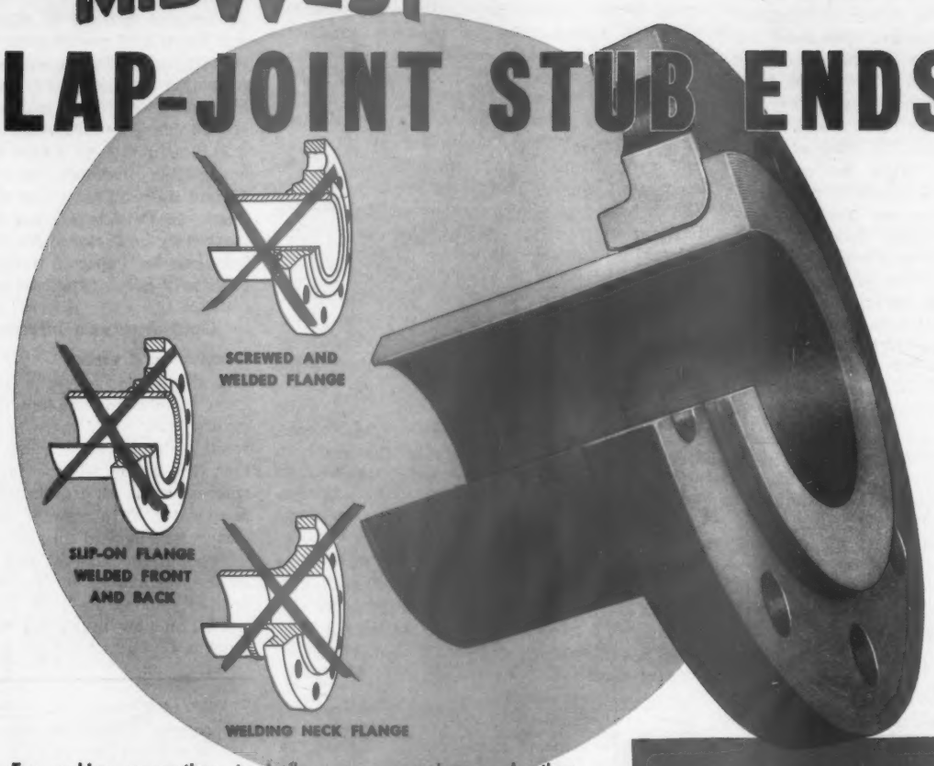
(Continued on Page 101)

*"Connate water" long has been incorrectly used to denote the water distributed throughout the reservoir rock at the time of exploitation. From its derivation, the word "connate" should be used only for the water in the sand as originally laid down. This water may have been changed many times by underground migration, and the water remaining with the oil at the time of exploitation more correctly should be called "interstitial water." The Pacific Coast district topical committee on production technology has worked up a glossary of terms in which this change is recommended. An attempt is being made to have this glossary released for publication, to start a movement toward clarification of meanings when opinions diverge, and to standardize the meanings of terms used in reservoir mechanics.

†The customary 0.1 per cent water cut in the production from a well making "clean oil" is, in the opinion of the author, not a small amount of interstitial water brought into the well by viscous drag of the flowing oil, but is water that was in solution in the oil formation. Any cut much greater than this comes from a wet sand producing mainly water and little oil.

MIDWEST

LAP-JOINT STUB ENDS



For making connections to boilers, pumps, valves and other flanged outlets (and where piping must be frequently cleaned or inspected for corrosion), Midwest Lap-Joint Stub Ends have a tremendous advantage over flanges that are welded to the pipe (see drawings above). The swivel flange on the Stub End makes it unnecessary to accurately line up the bolt holes before welding; "setting up" is simple and quick because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. The result is a real saving in time and cost of welding.

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MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

Corrosion Prevention on Water Side of Refinery Equipment

A.—Chemical Treatment of Water

By W. H. ATTWILL
Texas Co., Port Arthur, Tex.

IN recent years the trend toward the installation of cooling towers to provide large quantities of cool water for condensing and cooling equipment often has resulted in serious corrosion on the water side of refinery equipment. Some of the waters used for makeup to these cooling towers are not corrosive and, when concentrated, tend to form a protective coating—usually of calcium-carbonate nature — on the surface of the metal with which they come in contact. Other makeup waters, however, which may or may not be normally corrosive, when concentrated several times and completely saturated with dissolved oxygen in cooling towers, become very corrosive to the metals generally used in refinery cooling systems.

Several steps have been taken by members of the oil-refining industry to reduce the water corrosion in these cooling-tower systems, the most commonly used method being the chemical treatment of the circulating water. Although the object of this paper is to discuss the practical application and results of the chemical treatments applied to several of the recirculated cooling-tower systems at the Port Arthur, Tex., refinery of the Texas Co., a few words should be said first about the theory behind these treatments.

Theory of Chemical Treatments

Practically all forms of chemical treatments applied to cooling waters for corrosion control have, as their object, the formation of a more or less impervious film on the surface of the metals in contact with the water. Many chemicals have been used for this purpose—among them sodium hydroxide, calcium hydroxide, sodium carbonate, sodium silicates, sodium phosphates, sodium dichromate, sodium hexametaphosphate, and certain organic compounds. The films produced by these corrosion inhibitors may be of appreciable thickness, such as are formed by the silicates, or they may be so thin as to be practically invisible. In the case of the chromates, the corrosion-resistant coating produced is said to be an invisible film of ferric and chromic oxides.[1]

The efficiency of a chemical treatment depends upon how complete and impenetrable the film becomes. If the film formation is not complete, rapid localized corrosion may result from the setting up of concentration cells. In chemically treating cooling water for corrosion control it is always wiser to overshoot the mark than to court the danger of having insufficient inhibitor present.

Development of Corrosion Problem

In less than 1 year after the installation, in 1935, of two large cooling towers at the location mentioned, water-corrosion problems increased and became progressively more severe as additional towers were installed. During the following years the use of special condenser-tube alloys in certain locations, and the use of better makeup water to some of the cooling towers, decreased—but by no means eliminated—the corrosion problem, and it became evident that some corrective steps must be taken if any material reduction in water corrosion was to be accomplished. The application of chemical treatments seemed to offer the most likely solution.

A.P.I.

Increased use of cooling towers has increased considerably water-corrosion problems in refinery equipment. Chemical treatment of the water as a corrective measure has been resorted to, and this first portion of the paper discusses four treatments tried at the Port Arthur, Tex., refinery of the Texas Co.

Sodium hydroxide and sodium silicate treatments resulted in little, if any, reduction in the rate of corrosion. Chromate treatment, after 2½ years' use, has proved very effective; and, although it has not entirely eliminated corrosion, the large reduction in condenser-tube losses has more than offset the relatively low cost of treatment. Sodium hexametaphosphate as a corrosion inhibitor is under trial, and offers a less expensive treatment; but its efficiency is yet to be proved.

Paper was presented at the group session on refining, before the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

Caustic and Silicate Treatments

Four chemical treatments have been tried to date in one or more cooling-tower systems. The first treatment applied was the daily addition of sodium hydroxide to a natural-draft type of cooling-tower system, with a circulating rate of 7,000 g.p.m., to maintain a pH (hydrogen-ion concentration) of 8.0 to 8.5, as compared to a former pH of 7.0 to 7.5. After a 3-month trial this treatment was discontinued, as no reduction in corrosion was obtained. Sodium-silicate treatment was attempted next, in five cooling-tower systems, being added in sufficient amounts to increase the alkalinity approximately 25 p.p.m.; but, after trials for periods as long as 7 months, no improvement was noted. If anything, the silicate treatment aggravated conditions by binding the dirt and iron oxide present in the cooling water, with the resultant stoppage of water-supply lines and condenser tubes. There are many types and strengths of sodium silicates, however, and it is entirely possible that better results would have been obtained with other forms of silicates than the one used.

Chromate Treatment

Following these failures, the addition of sodium dichromate was tried in a mechanical-draft type of cooling-tower system with a capacity of 1,000 g.p.m., where serious water corrosion had been taking place. A great reduction in corrosion of both the copper-base condenser tubes and the steel and cast-iron water-supply lines was immediately apparent.

An example of this reduction in corrosion is illustrated in Fig. 1. The upper half of Fig. 1 shows the corrosion, after 270 days' service, on a piece of 3-in. standard steel pipe taken from the outlet-water line of one of the condensers before chromate treatment was started. The severe pitting best can be seen by observing the wall thickness at the right. The lower half of Fig. 1

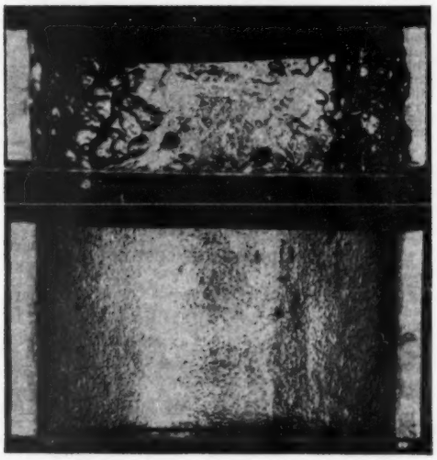

Fig. 1—Reduction in water corrosion with chromate treatment. Top: 270 days, without chromate. Bottom: 241 days, with chromate

shows the corrosion on a piece of 3-in. standard steel pipe, from the same location, after 241 days' service with the chromate-treated water. The great reduction in corrosion can be observed readily. It is interesting to note that the small amount of corrosion that did take place in the latter specimen is of a uniform nature, with no deep pits in evidence.

After the success obtained with the chromate treatment in this first location, the treatment gradually was extended to other cooling-tower systems. At the present time this method of corrosion control is in use in five cooling-tower systems, three of the mechanical-draft and two of the natural-draft type, with a total circulating capacity of 36,000 g.p.m.

Chromate Treatment in Mechanical-Draft Towers

In applying the chromate treatment to mechanical-draft cooling towers, a concentration of 500

p.p.m. of chromate—as $Na_2Cr_2O_7 \cdot 2H_2O$—is maintained in the circulating water by the daily addition of sodium dichromate. Sufficient caustic is added to convert the dichromate to the normal chromate and give a pH of 8.0 in the water. Small amounts of sodium hexametaphosphate also are added daily, so as to give a concentration of 5 to 10 p.p.m. of total phosphate, as PO_4. Experience indicates that the presence of a few parts per million of the metaphosphate (and the orthophosphate resulting from its conversion) tends to keep the condenser tubes and supply lines free from mineral and corrosion deposits. The presence of phosphate is said also to improve the corrosion-resistant properties of the chromate film.[2]

As the windage loss from mechanical-draft towers is negligible, it is necessary to control the total solids concentration of the circulating water by bleeding off some of the concentrated water. This is done by continuous blowdown from the tower system, regulated to limit the sodium-chloride concentration to about 850 p.p.m. With a makeup water of approximately 120 p.p.m. of sodium chloride, this allows seven concentrations in the circulating water. A typical analysis of the cooling-tower makeup water is given in Table 1.

TABLE 1—TYPICAL ANALYSIS OF MAKEUP WATER

	Parts per million
Residue on evaporation	236.0
Organic and volatile	51.0
Suspended matter	29.0
Iron oxide and alumina (R_2O_3)	18.2
Silica (SiO_2)	32.5
Calcium (Ca)	11.5
Magnesium (Mg)	5.4
Sodium (Na)	50.4
Sulfate (SO_4)	18.5
Chloride (Cl)	73.2
Carbonate (CO_3)	0.0
Bicarbonate	46.3
Free carbon dioxide (CO_2)	1.0
pH*	7.2

*Hydrogen-ion concentration.

TABLE 2—TUBES IN SERVICE AND TUBE REPLACEMENTS ON CONDENSERS IN USE IN COOLING-TOWER SYSTEMS

Year	Tubes in service	Tubes replaced	Replacement (per cent)
1936	44,415	11,867	27
1937	51,002	8,566	17
1938	55,867	20,437	37
1939	57,306	6,955	12
1940	73,025	5,721	8

Chromate and threshold treatments first started in 1939, and extended to other towers during 1939 and 1940. Tubes in service only a part of one year are averaged to show the number in service a full year.

Best results from this treatment naturally are obtained with an entirely new cooling-water system; but results in an already corroded system are often more evident, because it permits a comparison with the conditions before treatment. In one of the newer cooling-tower systems that has received chromate treatment since its installation, more than 11,000 red-brass condenser tubes have been in water service for more than 18 months without any replacements; and, in a second system of more than 3,000 red-brass tubes, no failures have occurred in 26 months. Examination of the equipment shows very little corrosion in the steel and cast-iron water-supply lines and cast-iron condenser heads. Failures of red-brass tubes usually begin to occur within a few months, and the tube bundles require replacement within 18 to 24 months in similar service without chromate treatment.

Test pieces of various metals placed in the outlet-water boxes of condensers before and after chromate treatment show a 75 per cent or better reduction in corrosion on boiler steel, and practically no corrosion on red brass and admiralty metal.

Chemical costs of the chromate treatment in mechanical-draft cooling towers have averaged about $35 per month per 1,000 g.p.m. of water circulated; but this cost is justified amply by reduction in corrosion in condenser tubes and water-supply lines, better heat-transfer rates, fewer shutdowns and generally better operation of the refining units.

Chromate Treatment in Natural-Draft Towers

During the past year chromate treatment was started in two natural-draft cooling-tower systems. Because of the relatively high windage loss from these towers, chromate concentration has been held at 100 to 150 p.p.m. in order to reduce the chemical costs. Caustic and sodium hexametaphosphate have been carried at the same concentrations as in the mechanical-draft towers. Although it is too early to predict the amount of corrosion reduction that will be obtained with this lower chromate concentration, indications are that an appreciable decrease will be secured. The cost of the chromate treatment in natural-draft towers has averaged approximately $20 per month per 1,000 g.p.m. of water circulated.

A word or two of warning should be given about the chromate treatment. Operators handling the sodium dichromate should wear rubber gloves and should be careful to avoid any contact of the chemical with the skin, or the so-called "chrome itch" might result. The hands and wrists should be washed carefully with fresh water after the chemicals have been handled. The chromate-treated water itself is not believed to be dangerous, due to the relatively low concentrations of chromate present; but it is advisable to prevent, as much as possible, its contact with the skin. In 2½ years' experience with this treatment, no trouble has occurred from the sources mentioned.

Because of windage losses, chromate-treated water in a natural-draft tower will deposit a thin greenish-yellow film on the surrounding equipment; but this film has been no more noticeable than the iron-oxide coating deposited by untreated water. Under certain conditions, however, this feature might be objectionable.

Sodium-Hexametaphosphate Treatment

Sodium hexametaphosphate has been used for several years to retard calcium-carbonate deposition from scale-forming waters. The apparent reason for this phenomenon is the adsorption of hexametaphosphate on the surface of the metal.[3] With this film formation on the metal in mind, it was decided to try the so-called "threshold treatment" in two cooling towers to determine if the film produced would retard corrosion. If successful, the treatment would give low-cost corrosion control that would be particularly adaptable to natural-draft towers with their high windage losses.

The threshold treatment was started on the first tower in August 1939 and extended to the second tower in January 1940. In this treatment a concentration of 2 to 5 p.p.m. of sodium hexametaphosphate is maintained in the circulating water by the addition of the required amount of metaphosphate once every 6 hours. Sufficient caustic also is added to maintain a pH value between 7.5 and 8.0. Although the corrosion-reduction properties of this treatment have not been well established, there are indications that some reduction in corrosion may be obtained, but to a definitely lesser extent than with the chromate treatment. The threshold treatment recently has been recommended for the control of cold-water corrosion.[4] Cost of the threshold treatment has averaged $10 a month per 1,000 g.p.m. of water circulated.

Reduction in Condenser-Tube Corrosion

Table 2 shows a tabulation of condenser-tube losses in cooling-tower systems before and after chemical treatment had been established. The table shows the high rate of replacement before the chromate and threshold treatments were started in 1939, and the reduction in these losses as the treatments were extended to additional tower systems. As some of these treatments were not started until well along in 1940, a still greater reduction is expected in 1941.

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B.—Use of Deaerator

By W. H. ATTWILL
Texas Co., Port Arthur, Tex.

The mechanical deaerator described in this paper greatly retards water corrosion in condenser tubes and water-supply lines by removing 98 per cent of the dissolved oxygen from the cooling water. The deaerating equipment is reliable in operation, requiring little attention and maintenance, and may be used with equal efficiency on either a "recirculated" or "once-through" cooling-water system. Installation cost is high, but operating costs are relatively low.

MOST of the corrosion-control work on refinery cooling-water systems may be classified under three general methods: (1) The use of corrosion-resistant metals and alloys; (2) the use of chemicals to deposit a protective film on the metal; or (3) the application of cathodic protection. All of these methods have been successful in some cases, and have failed in others. A new development in this field is the mechanical deaeration of refinery cooling water.

Experience shows that, in a corrosive water that is normally alkaline, dissolved oxygen is the main factor in corrosion. Eliminate the dissolved oxygen and you eliminate the corrosion, whether it be the dezincification-type corrosion of admiralty condenser tubes, the pit-type corrosion of red-brass tubes and steel pipe, or the general corrosion of cast iron.

Deaeration long has been used for the removal of dissolved oxygen from boiler feed water, but only recently has this principle been applied to corrosion control in refinery cooling-water systems. The methods of deaeration differ, however, in that in most cases heat—in the form of steam—is used in the deaeration of boiler feed water, whereas a high vacuum is employed in cold-water deaeration.

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*The reference here is to stresses caused by line movements due to expansion, rather than those caused by internal pressure. Mathematical analysis shows that stresses are maximum in the curved section of the fitting and that such stresses far exceed those existing in the straight section even at points quite close to the point of tangency.

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†Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

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reduce cooling-water corrosion, installed a mechanical deaerator on one of the recirculated cooling-tower systems at its Port Arthur, Tex., refinery. This deaerator is installed on a recirculated system utilizing a forced-draft type of cooling tower, with a circulating rate of 1,500 g.p.m. All the waters available in this area are normally corrosive non-scale-forming waters. The makeup water to this particular system is of low chloride low hardness content, and gives a pH of 8.0 to 8.5 when concentrated in the cooling tower.

Details of Deaerator

The general arrangement of the deaerator is shown in Fig. 1. The cold water from the cooling-

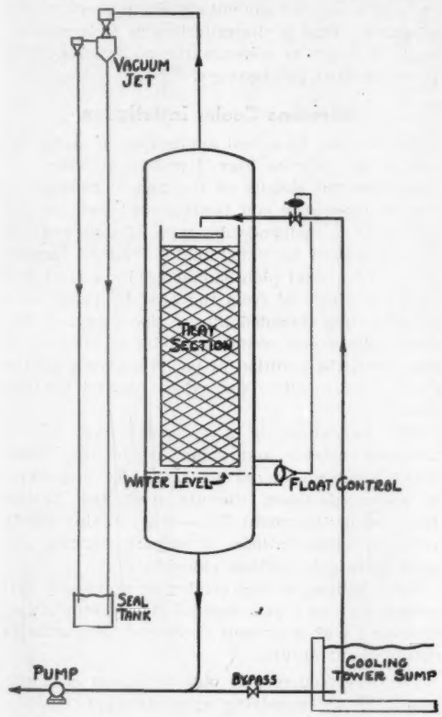


Fig. 1.—General layout of deaerator

tower sump is drawn into the 6 by 20-ft. deaerator tower by the high vacuum maintained by a two-stage vacuum jet. A diaphragm-operated inlet valve regulates the flow of water to hold a level just below the tray section. As the water passes down through the tray section, it continually is broken up into films or sheets, exposing as much water surface as possible to the high vacuum. Under these conditions, most of the oxygen is released from the water and is drawn out through the vacuum jet. A single-stage centrifugal pump takes suction on the bottom of the deaerator tower and discharges to the refining unit.

The construction of the deaerator is in many ways similar to that of the one installed in Louisiana by a large sulfur company to protect a steel line in cold-water service* The two-stage vacuum jet was selected in preference to the vacuum pump because of its simplicity and reliability. The jet was designed to maintain a vacuum of 29.0 in. of Hg (referred to a 30-in. barometer) in the tower, and in actual operation the vacuum varies between 28.8 in. and 29.6 in. (referred to a 30-in. barometer), depending upon the circulating-water temperature. The tower itself was made from a second-hand vessel, and was coated carefully on the inside with a heavy layer of hot asphalt to retard the severe corrosion which otherwise would be expected to occur under the conditions of operation.

The tray section, on which the ultimate efficiency of the deaeration process depends, is of cypress-wood construction. It is designed to give an appreciable time element before the entering water reaches the bottom of the deaerator, and to provide ample venting of the tray areas for the easy removal of the gases released.

Of primary importance, if the high vacuum mentioned above is to be attained, is a complete absence of leaks in the entire equipment. Leaks above the water level reduce the vacuum by loading up the jets, whereas leaks below the water level actually contaminate the deaerated water with oxygen. Some trouble was experienced from this source during the initial stages of operation, but the liberal application of hot asphalt on all joints and connections eliminated this difficulty.

Oxygen-Removal Efficiency

Samples of water taken from the base of the deaerator during the past year show an average oxygen content of only 0.12 p.p.m. of oxygen, by the Winkler test, as compared with 6 to 7 p.p.m. in the water entering the deaerator, or an oxygen removal of about 98 per cent. The actual water supplied to the refining unit has had a slightly higher oxygen content, averaging about 0.2 p.p.m., because of packing-gland leakage in the centrifugal pump, which operates under a suction condition of 20 in. of Hg vacuum.

Corrosion Reduction in Condenser Tubes

Previous to the installation of the mechanical deaerator, serious water corrosion took place on the refining unit supplied by this cooling-tower system. Six of the nine water-cooled admiralty condenser-tube bundles failed completely after only 9 months' service, and two of the three remaining bundles failed 4 months later. Six of these failures were replaced with red-brass, one with copper-nickel, and the other with arsenical admiralty-metal tubes. Red brass was used instead of admiralty, as more recent experience indicates that red-brass tubes have, on the average, slightly longer life than admiralty-metal tubes for our particular conditions. Since the installation of the deaerator 2 years ago, no failures have occurred from water corrosion in any of the condensers.

Just before the construction of the mechanical deaerator a new test bundle, using steel tubes, was installed. This steel bundle now has been in service for 26 months without a tube failure—which is considered a remarkable record, inasmuch as our average life of steel tubes in water service is only 5 months.

Corrosion Reduction in Water Lines

Prior to the installation of the deaerator, severe water corrosion also took place in the steel and cast-iron water-supply lines. Tuberculation became so extensive in these lines that the centrifugal-pump discharge pressure increased from 47 to 63 lb. per sq. in., with a corresponding drop in the quantity of cooling water supplied to the unit. The pressure drop through the piping was reduced before the deaerator installation by circulating hot inhibited acid through the entire cooling system of the unit. Since the deaerator has been in operation, no increase in pressure drop has been noted.

Fig. 2 shows the reduction in corrosion on these supply lines by the mechanical deaerator. The upper half of Fig. 2 shows the corrosion, over a

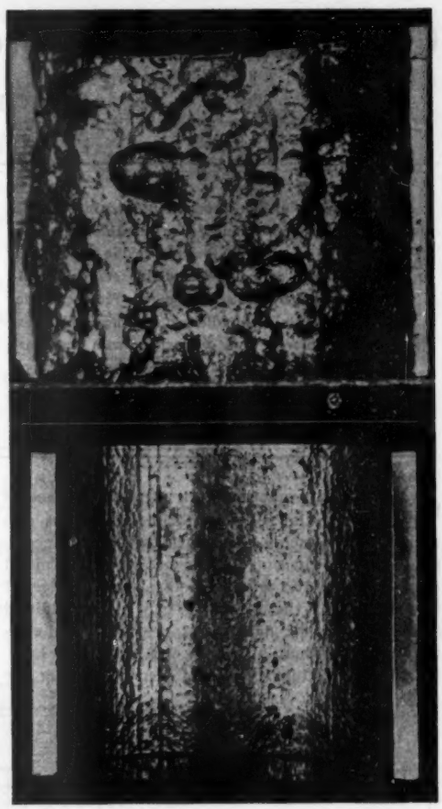


Fig. 2—Reduction in water corrosion with mechanical deaeration. Top: 268 days, without deaeration. Bottom: 181 days, with deaeration

268-day period, on a piece of standard 2-in. steel pipe, from the water outlet of No. 6 condenser, without deaeration of the water. This pipe actually had failed in the threads. The lower half of the figure shows the corrosion on a section of 2-in. standard pipe in the same location, after 181 days' service with deaerated water. The reduction in corrosion is self-evident. It might be mentioned here that these test specimens were located where the cooling water reaches the highest temperature on the unit, viz., 160° to 170° F.

TABLE 1—TYPICAL ANALYSIS OF MAKEUP WATER

	Parts per million
Residue on evaporation	181.0
Organic and volatile	20.0
Suspended matter	5.0
Iron oxide and alumina (R_2O_3)	2.0
Silica (SiO_2)	5.1
Calcium (Ca)	1.0
Magnesium (Mg)	0.2
Sodium (Na)	67.2
Sulfate (SO_4)	31.8
Chloride (Cl)	60.6
Carbonate (CO_3)	0.0
Bicarbonate (HCO_3)	37.5
Free carbon dioxide (CO_2)	1.0
pH*	7.5

Analysis of cooling-tower makeup water, both before and after the installation of the deaerator, has remained essentially the same.
*Hydrogen-ion concentration.

Costs and Savings

The use of sodium sulfite to remove the last traces of oxygen from the cooling water has been considered; but in view of the excellent results obtained to date, it cannot be justified economically. Cost of sodium sulfite to remove 0.2 p.p.m. of oxygen, plus 1 to 2 p.p.m. of excess sodium sulfite, would amount to approximately $100 per month.

Installation cost of the 1,500-g.p.m. deaerator was $8,100; and operating costs—including vacuum-jet steam, jet condenser water, and increased cost of pumping cooling water to the refining unit—have averaged $50 a month. In 2 years' time the deaerator has more than paid for both

*S. T. Powell and H. S. Burns, "Vacuum Deaeration Combats Cold-Water Corrosion," Chem. Met. Eng. 43, 180-84 (1936).

its installation and operating cost by reduction in condenser-tube corrosion alone. In addition, the deaerator has resulted in lower pressure drop and reduced repair costs of water-supply lines, better heat-transfer rates, fewer shutdowns, and better operation of the refining unit.

Conclusion

In conclusion, mechanical deaeration of refinery cooling water for corrosion control has the following advantages and disadvantages:

1. Water corrosion is reduced considerably in the entire cooling system, not just in individual pieces of equipment.

2. The deaerating equipment is reliable in operation, requiring little attention and maintenance.

3. The installation cost is high, but operating costs are relatively low.

4. Mechanical deaeration may be applied to both "recirculated" and "once through" cooling-water systems with equal efficiency, and with the same installation and operating costs.

C.—Cathodic Protection

By V. L. NEALY
Texas Co., Houston, Tex.

As a result of the success obtained in cathodic protection of pipe lines, considerable attention again has been given recently to the prevention of electrolytic corrosion in condensers and similar equipment by the same method. Prolonged life of condenser-tube bundles, operating under severe conditions and protected with counter-electrical currents, has proved the merits of cathodic protection in several instances. Closely allied with cathodic protection is the insulation of pipe connections to condensers to prevent the flow of current in or out of the bundles. This has been successful in at least one installation. Cathodic protection of condensers definitely has been proved an economical method of corrosion prevention, but much investigation remains to be done in the development of empirical formulas or equations from which the current density necessary under widely varying conditions of operation can be solved.

CATHODIC protection of a metallic surface is based on the fundamental concept that corrosion in an aqueous solution invariably is accompanied by a current discharge from the metal (electrode) to the water (electrolyte). Hence, if the surface of the electrode can be maintained at a potential sufficiently below that of the electrolyte, no current discharge will occur.

In practice, this is accomplished by raising the potential of the water with the aid of one or more anodes supported in the water passageways, and insulated from the vessel. Because the current is forced to travel from the anode to the water and then to the shell, the water necessarily must be positive to the latter, so that further corrosion is inhibited. Of course, the anodes are more or less rapidly dissolved, but their replacement cost is negligible in comparison with that of a condenser-tube bundle, for example.

Although cathodic protection of boilers and condensers has been attempted for a number of years with some degree of success, it has remained largely in the experimental stage. Recently, since the general acceptance of this method of corrosion prevention as applied to underground pipe lines, a renewed interest has been taken in protection of condensers, with pipe-line experience serving as a basis or background for the design and operation of cathodic-unit installations on condensing equipment. However, there are several notable differences in application and in checking operation. For example, in pipe-line service, the degree of protection ordinarily is determined by potential measurments; whereas, in condensers, the current density per square foot of surface area is the criterion, as it is mechanically difficult to measure the potential existing in constricted passageways.

Kerosene Cooler Installation

To consider an actual application of condenser protection, refer to Figs. 1 and 2, in which are illustrated the details of the anode installations for the fixed-head and floating-head ends, respectively, of a shell-and-tube type of unit. In the former it will be noted that an anode consists simply of a steel plate supported by a steel rod, which is insulated from the head by means of a bakelite tube threaded into a pipe coupling. The floating-head end contains anodes of similar design, with the addition of packing glands on the shell cover to allow for expansion and contraction.

This condenser is a two-pass type, having kerosene outside and water inside the tubes, which are made of red brass. The cooling water is untreated—taken directly from the Neches River below Beaumont, Tex.—and contains widely varying concentrations of organic matter and salts, principally sodium chloride.

Tube failures at this condenser previously had occurred every 3 to 6 months in new bundles, as compared with a present service of 15 months to date without failure.

The direct current is obtained from a motor-generator set supplying approximately 1¾ amperes—at varying voltages to correspond to varying cooling-water salinity or conductivity—to each of the four anodes.

Multiunit Installation

Fig. 3 is a schematic diagram of cathodic protection of 16 shell-and-tube-type condensers and coolers located on a pipe still, showing the general arrangement, wiring, number of anodes in each unit, and operating data—including the surface area and total current for each condenser.

(Continued on Page 99)

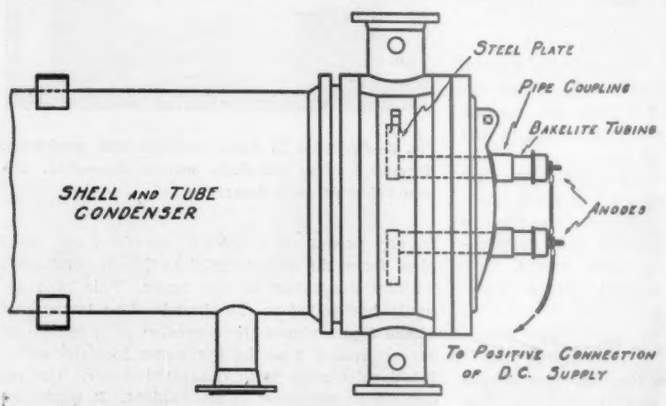


Fig. 1 (left)—Anode installation in fixed-head end of condenser

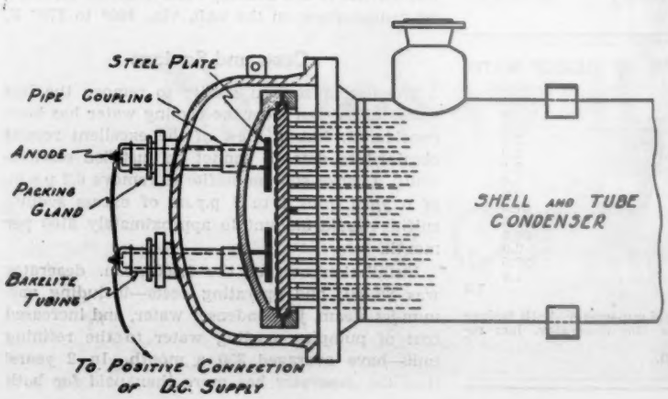


Fig. 2 (lower left)—Anode installation in floating-head end of condenser

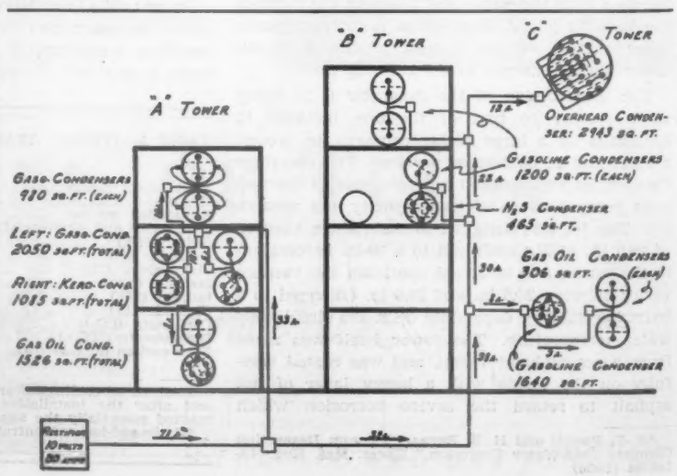
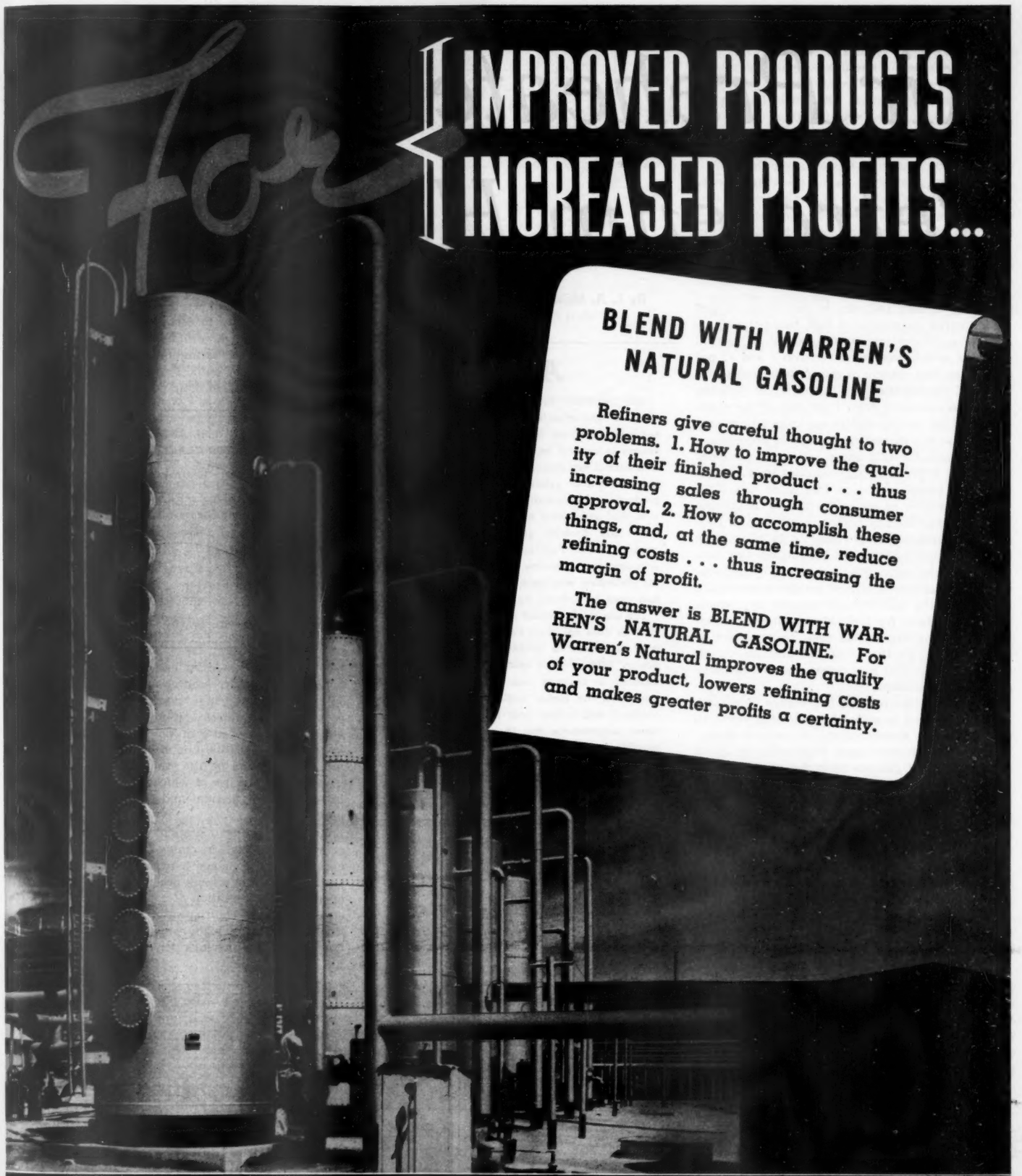

"B" TOWER
"C" TOWER
"A" TOWER
OVERHEAD CONDENSER: 2943 SQ. FT.
GASOLINE CONDENSERS 1200 SQ. FT. (EACH)
GASO. CONDENSERS 930 SQ. FT. (EACH)
H_2S CONDENSER 465 SQ. FT.
LEFT: GASO. COND. 2050 SQ. FT. (TOTAL)
RIGHT: KERO. COND. 1015 SQ. FT. (TOTAL)
GAS OIL CONDENSERS 306 SQ. FT. (EACH)
GAS OIL COND. 1526 SQ. FT. (TOTAL)
GASOLINE CONDENSER 1640 SQ. FT.

Fig. 3 (below)—Schematic diagram: Cathodic installation at a pipe still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Air Preheaters for Petroleum Heaters

By L. A. MEKLER and H. A. BECKER
Universal Oil Products Co., Chicago

A.P.I.

The petroleum industry consumes the equivalent of approximately 100,000,000 bbl. of fuel per year. Because of ease of handling and response to manual and automatic control, refinery and natural gas represent 65 per cent of the total. Improvement in refinery technique reduced the production of nonsalable solid and liquid byproducts, and processing of refinery gas to the ultimate may diminish greatly the supply of the gaseous fuels. Fuel savings, therefore, are an economic and operating necessity. Installation of air preheaters may save up to 25 per cent of the fuel used by refinery heaters.

The use of air preheat on a heater designed for cold air does not affect heat distribution materially if the heater is operated at the original capacity. With a given amount of fuel burned, an increase in capacity can be obtained with air preheat if the higher radiant-heat-transfer rates obtained with higher heat liberation and higher flame temperatures due to air preheat are permissible in the heater.

Paper was presented at the group session on refining, before the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

THE petroleum industry is one of the largest industrial consumers of fuel, using the equivalent of approximately 100,000,000 bbl. of fuel oil per year, which represents between 8 and 12 per cent of the heat content of the crude oil processed. The fuel requirements of the different refining operations may vary from 2 per cent of the crude processed for simple distillation up to 20 per cent for some of the thermal and catalytic processes.

Until quite recently most refineries produced nonsalable byproducts in quantities greater than their fuel requirements, so that there was little, if any, incentive to conserve fuel by improving the firing practice and by the installation of fuel-saving equipment. Improvements in oil-refining technique practically have eliminated the nonsalable liquid, semiliquid, or solid byproducts, and the development of new processes materially is reducing the quantities of gaseous byproducts that are available for fuel. Most refineries, therefore, are using marketable fuels to a greater or lesser extent, so that fuel becomes an out-of-pocket expense that may affect the net earnings of refinery operations.

Fig. 1 shows the relative importance of the different fuels used in refineries in recent years, as disclosed by a survey of the Bureau of Mines. The trend is definitely away from solid and liquid fuels in favor of gaseous fuels, because these latter fuels are more amenable to manual—and particularly to automatic—control, which is desirable in the more exact refining operations carried out at present. In 1937 refinery and natural gas represented better than 65 per cent of the total fuel consumption of the refineries covered by the survey—with fuel oil, coal, and coke together making up the remainder. Although the present trend is toward a still greater use of gaseous fuel, the available supply of gaseous fuel, particularly of refinery gas, is on the decline because of the utilization of refinery gas as raw material for the various processes for the manufacture of high antiknock motor fuels, alcohols, intermediate chemicals, etc.

Depletion of Heating Value

Table 2 and Fig. 2 show the rate of depletion of the available heating value of a representative cracking-plant gas shown in Table 1 after this gas has been subjected to certain processes for ultimate yield of high antiknock motor fuels. Depending on the processing methods used, the gross heat available per cubic foot of the original gas is reduced from 1,786 B.t.u. per cu. ft. to 744 B.t.u. per cu. ft. in one case, and to 1,169 B.t.u. per cu. ft. in the other—representing a loss of 58½ per cent and 34½ per cent, respectively. Fuel economies in refineries, therefore, become desirable not only because of possible direct savings in the refining costs, but also because they permit conservation of the diminishing supply of gaseous fuel, the use of which is often a necessity in some of the thermal and catalytic oil-refining processes.

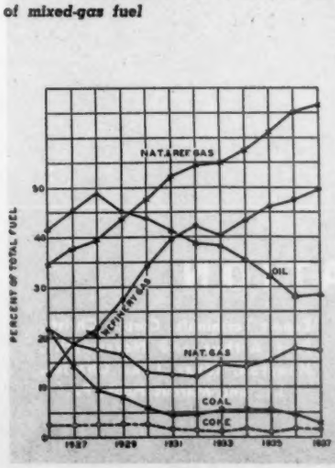
TABLE 1—COMPOSITION AND HEATING VALUE OF TYPICAL DUBBS CRACKING-PLANT GAS

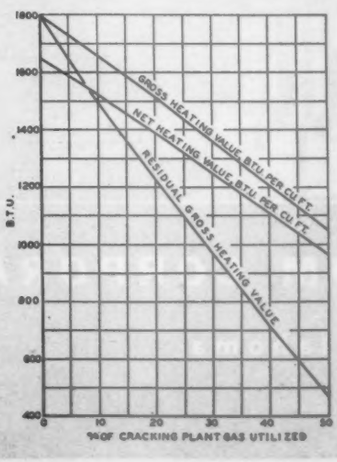
Component	Mol per cent	Heating value (B.t.u. per cu. ft.) Gross	Net	Σ Heating value (B.t.u. per cu. ft.) Gross	Net
H_2	6.4	325	274	21	18
CH_4	30.6	998	900	305	276
C_2H_4	5.1	1,591	1,491	81	76
C_2H_6	19.1	1,759	1,610	336	308
C_3H_6	10.6	2,347	2,198	249	233
C_3H_8	16.8	2,532	2,330	425	392
C_4H_8	5.9	3,148	2,933	186	173
C_4H_{10}	5.5	3,329	3,076	183	169
Total	100.0			1,786	1,645

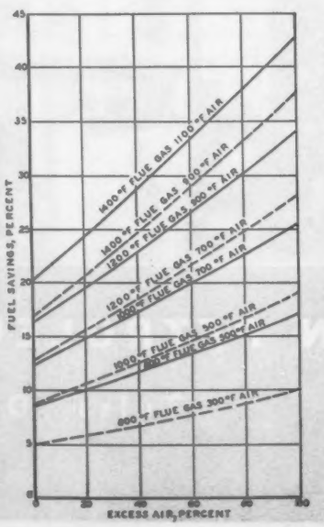
Specific gravity = 1.05.

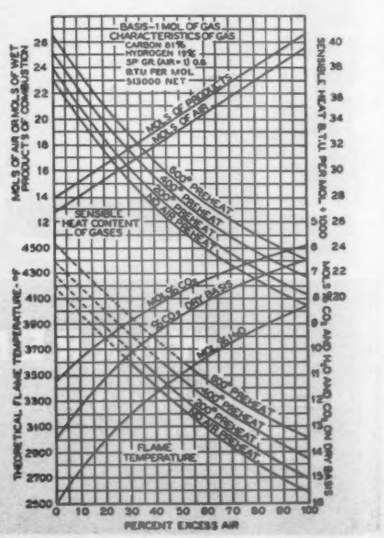
Most oil-refining operations are carried out at comparatively high incoming-oil temperatures because of heat exchange between the incoming oil and hot liquids or vapors produced in the refining operation. Conservation of cooling water or a desire to obtain certain specific types of fractionation often is the main cause of such heat exchange—the fuel savings being of secondary con-

Fig. 1 (left)—Relative importance of fuels used in refineries. Fig. 2 (left, center)—Rate of depletion of heating value of cracking-still gas with processing. Fig. 3, (right, center)—Fuel savings due to air preheat. Fig. 4 (right)—Combustion characteristics of mixed-gas fuel




GROSS HEATING VALUE, BTU PER CU.FT.
NET HEATING VALUE, BTU PER CU.FT.
RESIDUAL GROSS HEATING VALUE
B.T.U.
% OF CRACKING PLANT GAS UTILIZED


1400°F FLUE GAS 1100°F AIR
1400°F FLUE GAS 900°F AIR
1400°F FLUE GAS 700°F AIR
1200°F FLUE GAS 700°F AIR
1200°F FLUE GAS 500°F AIR
1000°F FLUE GAS 500°F AIR
800°F FLUE GAS 300°F AIR
600°F FLUE GAS 300°F AIR
FUEL SAVINGS, PERCENT
EXCESS AIR, PERCENT



sideration. Because of the high inlet-oil temperatures, the temperature of the gases leaving most petroleum heaters is also comparatively high, ranging between 700° and 1,400° F. Depending on the amount of excess air used for combustion and the stack temperature, the losses in the flue gases may be as high as 40 per cent of the generated heat, and are seldom less than 25 per cent. These losses may be cut to less than half by heat-exchanging the flue gases with the air for combustion.

Economy of Heat-Exchanging Flue Gas

Fig. 3 shows the saving of fuel that can be obtained by heat-exchanging flue gases at temperatures of 800°, 1,000°, 1,200°, and 1,400° F., with the air used for combustion to preheat the air to within 300° and 500° F. of the respective flue-gas temperatures when an average mixture of natural and refinery gas with various percentages of excess air is burned. The combustion characteristics of the gas are shown in Fig. 4. The fuel requirement at given flue-gas temperature and excess air, with no air preheat, is used as a base in the curves of Fig. 3. For example, with a flue-gas temperature of 800° F. and 50 per cent excess air preheating the air to within 300° F. of this temperature (500° F. air) saves 12.5 per cent of the fuel that would be required with the same excess air if not air preheat were used.

Fig. 5 shows more specifically the savings that can be obtained by recovering heat from flue gases at an original temperature of 1,070° F. by preheating the air to temperatures up to 700° F., with various percentages of excess air used for combustion. The fuel requirement for any given excess air and with no air preheat is used as a base in these curves. The curves show that the higher the excess air that must be used in a given heater, the greater are the savings obtainable with air preheat.

Economy of Air Preheat

Fig. 6 shows the fuel savings that can be obtained by air preheat, by reduction of the excess air used, and by a combination of both. The fuel requirement with 100 per cent excess air and no air preheat is used as a base in these curves. The curves show that within certain limits of possible savings, air preheat and reduction of excess air are interchangeable, and that the savings obtained by using both are cumulative. For example, a reduction of excess air from 100 per cent down to 50 per cent without air preheat results in a fuel saving of approximately 13 per cent, which is equivalent to the saving that can obtained by preheating the air to 340° F. without reducing the excess air used. By reducing the excess air to 50 per cent and preheating the air to 340° F., a cumulative saving of approximately 21 per cent of the fuel used with 100 per cent excess air and no air preheat can be obtained.

With other things being equal, preheating of air results in more rapid and complete combustion so that, for given flame characteristics, the use of preheated air will assist in reducing the excess air used for combustion—thus making the cumulative fuel savings possible.

Modern petroleum heaters supply the major portion of the total heat absorbed by the oil by radiation, and their operation usually is determined by the rates of radiant-heat transfer that can be obtained and safely applied to the oil. The rates of radiant-heat transfer are determined by the flame temperature and by the quantity of heat liberated per square foot of projected effective heat-absorbing surface subjected to radiation. The relationship between the flame temperature, the quantity of liberated heat, radiant-heat absorption, and residual-gas temperature is shown in Fig. 7.

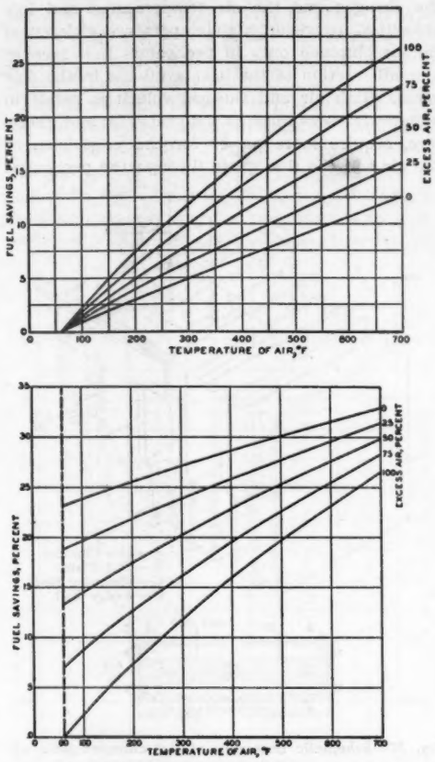
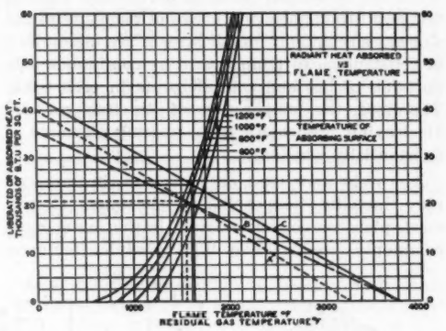


Fig. 5 (top)—Fuel savings with air preheat for various air temperatures and excess air used—flue-gas temperature, 1,070° F. Fig. 6 (bottom)—The effect of air preheat and excess air on fuel savings—flue-gas temperature, 1,070° F.

Air preheat increases the flame temperature. Air preheat, however, results in a reduction in the amount of fuel used, so that, even with the additional heat brought in by the preheated air, the heat liberation per square foot of effective projected surface for a given capacity of the heater is lower with air preheat than without it. The increase of radiant-heat absorption due to higher flame temperature is almost equal to the decrease due to lower heat liberation. Therefore, if the heater is operated at the same capacity in each case, the total radiant-heat absorption in a heater and the relationship between the radiant and convection heat pickup remain practically the same whether preheated air or cold air is used. Preheated air can be used to increase the total capacity of a heater designed for cold-air firing, provided the increase will not overload the radiant-heat-absorbing surfaces which will be affected most by this increase. Higher amounts of liberated heat obtained at the higher capacity and the higher flame temperature obtained with preheated air will have an accumulative effect, so that the radiant-heat transfer rates will increase almost in proportion to the increase in capacity. The convection rates are changed very little with air preheat, within the range of capacity increase that is safe for the radiant-heat-absorbing surfaces.

Recuperative Preheaters

Air preheaters can be divided into two main classes—recuperative air preheaters and regenerative air preheaters. In recuperative preheaters the heat interchange between the flue gases and the air is obtained by continuous heat flow from the flue-gas stream to the air stream through a membrane which separates the streams from each other. With normal flue-gas and air-flow conditions, this membrane is maintained at a substantially constant equilibrium temperature at any given point. The equilibrium temperature is approximately the mean of the flue-gas and air temperatures at the point of contact. In properly designed recuperative air preheaters all elements perform in a similar manner, and the flue-gas and air streams leave the preheater at substantially constant temperatures.



Example:	A No air preheat	B Preheated-air temp., 660° F.; heater capacity same as "A"	C Preheated-air temp., 660° F.; heater capacity increased 15 per cent
Flame temp., °F.	3,250	3,750	3,750
Liberated heat per sq. ft. of equivalent effective surface, B.t.u.	40,000	36,000	42,500
Temp. of heat-absorbing surface, °F.	800	800	800
Absorbed radiant heat per sq. ft. of equivalent effective surface, B.t.u.	21,000	21,000	24,000
Residual temperature of gases, °F.	1,550	1,550	1,580

Fig. 7—Radiant-heat absorption relationships

Regenerative Preheaters

In regenerative preheaters the heat interchange is obtained by storing heat from the flue gases in the elements while they are in the flue-gas stream during the heating cycle, and by the recovery of this heat by the air while the elements are in the air stream during the cooling cycle. The elements of regenerative air preheaters vary in temperature from substantially the temperature of the

TABLE 2—DEPLETION OF HEATING VALUE OF CRACKING-PLANT GAS BY VARIOUS PROCESSING METHODS

Processing method—	Cubic feet	Heating value (B.t.u. per cu. ft.) Gross	Heating value (B.t.u. per cu. ft.) Net	Residual gross heat available per original cubic foot
Original gas	1.000	1,786	1,645	1,786
After selective polymerization	0.971	1,748	1,605	1,698
After selective and nonselective polymerization	0.835	1,620	1,482	1,352
After selective and nonselective polymerization and butane dehydrogenation	0.780	1,498	1,372	1,168
After selective and nonselective polymerization and butane and propane dehydrogenation	0.612	1,215	1,110	744
Alternate processing method—				
After alkylation	0.923	1,678	1,532	1,550
After alkylation and dehydrogenation	0.886	1,600	1,471	1,418
After alkylation, dehydrogenation, and nonselective polymerization	0.780	1,498	1,392	1,169

flue gases at the highest point to substantially the temperature of the air at the lowest point of the temperature cycle. Regenerative preheaters may be of the stationary-element type, containing two sets of elements—one set being heated while the other is being cooled, with the flow of air and the flue gas alternately reversed from one set to the other; or they may be of the rotating-element type—wherein the elements are made to pass, from one portion of the cycle, through the gas stream to absorb the heat from it and, for the remainder of the cycle, through the air stream to transfer the stored heat to the air.

In regenerative air preheaters with stationary elements, the temperatures of the cooled flue gases and the preheated air leaving the preheater vary through each cycle. The shorter the cycles, the more uniform these temperatures will be. In regenerative preheaters with rotating elements, while the individual elements go through a cyclic temperature change, the banks of elements in the flue-gas stream and the air stream are maintained at constant mean temperature by continuous substitution of hot and cold elements in each bank. Therefore, the temperature of the flue gas and air leaving preheaters with rotating elements is substantially constant.

Air preheaters used on petroleum heaters employ metallic heat-exchange elements. Carbon steel, plain or copper bearing, is the metal most commonly used. When high gas-inlet temperatures and high degrees of air preheat are used so that the heat-exchange elements are subjected to metal temperature in excess of 900° F., or when sulfur-containing fuels producing corrosive products of combustion are burned, oxidation and corrosion-resistant steels such as 4 to 6 per cent chrome, 12 per cent chrome, and 18-8, may have to be used locally or throughout the entire preheater. In recuperative air preheaters the highest obtainable metal temperature is approximately the mean of the highest flue-gas temperature and the highest preheated-air temperature. In regenerative air preheaters, the highest metal temperature approaches the highest flue-gas temperature. For given flue-gas and air-preheat temperature, the maximum metal temperature in a recuperative air preheater is considerably lower than it is in a regenerative type.

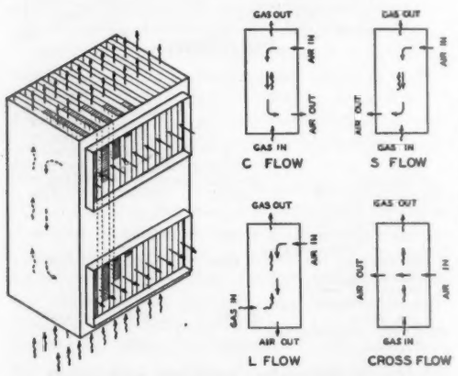


Fig. 8 (left)—Typical plate air preheater. Fig. 9 (right)—Typical air and gas flows through air preheaters

The effectiveness of heat-exchange elements in both the regenerative and recuperative air preheaters is determined by the logarithmic mean-temperature difference between the flue gas and the air and the overall heat-transfer coefficient which, in turn, is determined by the velocity of the gas and the air streams. Preheaters with large temperature differences and high velocities will, therefore, be smaller and less expensive than preheaters with a close approach between the flue-gas and the air temperatures and low velocities. However, high-temperature differences can be obtained only in preheaters that recover a small fraction of the heat available in the flue gases. High air and flue-gas velocities result in high draft losses through the preheater and, therefore, require more power for the propulsion of the air and the flue gases through the preheater.

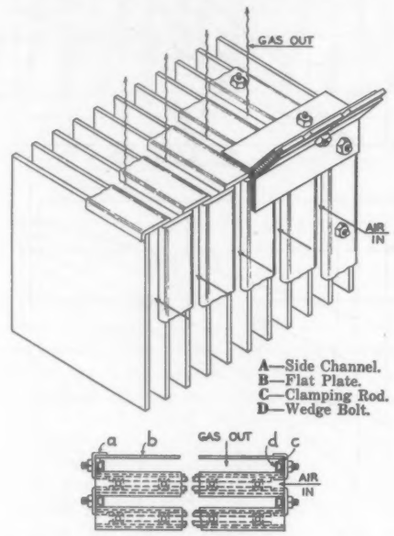


Fig. 10—Schematic assembly of flat clamped-plate envelop air preheater (courtesy Prat-Daniel Corp.)

Therefore, for a given fuel saving a small preheater with effective heat-exchange elements—although requiring a lower capital investment—will have a higher operating cost than a larger air preheater with less effective elements. An economic balance between the value of the fuel saved, the fixed charges, and the operating cost usually determines which air preheater best is suited for the particular installation.

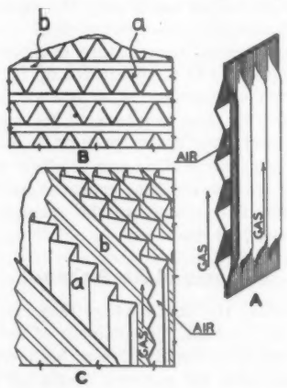
Plate and Tubular Air Preheaters

Recuperative air preheaters can be divided into plate air preheaters and tubular air preheaters, depending on the type of heat-exchange elements used. Fig. 8 shows schematically a typical plate air preheater. The preheater consists of a number of air chambers or "envelops" equidistantly spaced in a casing. The air passes through the envelops, and the flue gases between them. To keep the draft losses on the gas side to a minimum, the flue gases pass straight through the preheater from the bottom to the top. The air is made to change the direction of its flow through the envelop to increase the washing effect of the air upon the surface, and to accommodate air-inlet and outlet connections most suitable for the particular installation.

The various types of air flow that commonly are used in plate air preheaters are shown in Fig. 9. *C* flow is obtained on the preheater in Fig. 8, with the air-inlet and outlet connections as shown. The *C*, *S*, and *L* flows in Fig. 9 are shown with countercurrent flows of the air and the flue gas which give the most effective use of the heat-exchange surface employed and the closest approach between the temperature of preheated air and the temperature of the incoming gas. When only a relatively small percentage of the available heat in the flue gas is recovered in air preheaters, concurrent gas and air flows with the same types of air flow as shown in Fig. 9 often are used to simplify the duct arrangement. For the same amount of air preheat a greater amount of heating surface is required with concurrent than with countercurrent flows. With the same amount of heating surface, higher air preheats can be obtained with countercurrent than with concurrent flows. The cross-flow is limited to air preheaters with short elements. The gas and air-flow relationship in this flow is neither countercurrent nor concurrent. Under identical conditions of gas and air quantities, heating surface, and initial gas temperature, the heat recovery with cross-flow is less than with countercurrent flow, and more than with concurrent flow for the *C*, *S*, and *L* air flows shown.

With the *C*, *S*, and *L* flows, the temperature of the air leaving the envelops is uniform through out the cross-section of each envelop. With cross-flow and the gas flow as shown in the diagram, the temperature of the air leaving the bottom portion of each envelop is considerably higher than that of the air leaving the top portion, and the temperature of the preheated air as delivered to the burners is somewhere between these two temperatures. A thorough mixing of the air on the outlet of the preheater is necessary with a cross-flow to avoid delivering air of a different temperature to the different burners. . . .

Fig. 10 shows a schematic assembly of an air preheater with clamped-plate envelops. The gas and air passages are formed by alternately clamping flat plates in special channels which form the side closures. Sufficient pressure is applied upon



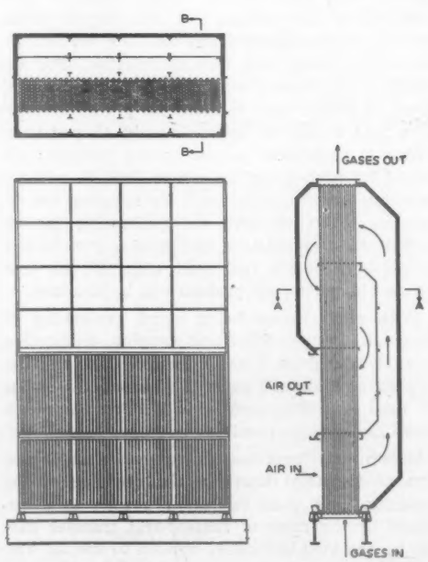


Fig. 11 (top)—Schematic assembly of corrugated welded-plate air preheater (courtesy Air Preheater Corp.). Fig. 12 (bottom)—Tubular air preheater (courtesy Foster Wheeler Corp.)

clamping rods, *C*, by the wedge head bolts, *D*, to make the joint sufficiently tight for the air and gas pressures normally prevailing in air preheaters. The joint, however, is loose enough to permit a slight movement of the plate between the tightening rod and the channel to take care of

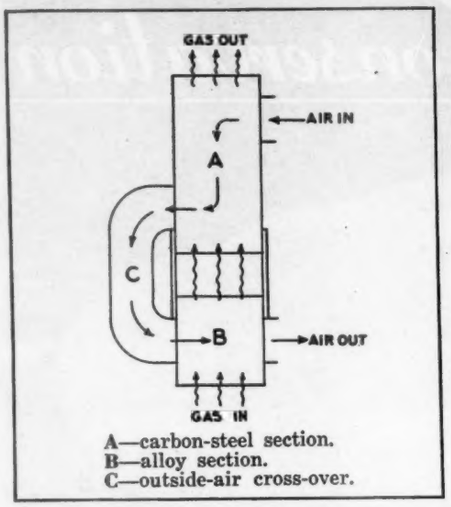


Fig. 13—Schematic arrangement of two-section air preheater

small amounts of differential expansion within the envelop—which is one of the advantages claimed for this construction. . . .

Fig. 11 shows a schematic assembly of an air preheater with the envelops made of welded corrugated or undulated plates. Alternate plates are undulated at right angles to each other to obtain the maximum turbulence of air and gas flow through the preheater, so that higher heat-transfer rates are obtained with a given size envelop that can be obtained with flat plates. The undulations are less frequent and are shallower across the gas

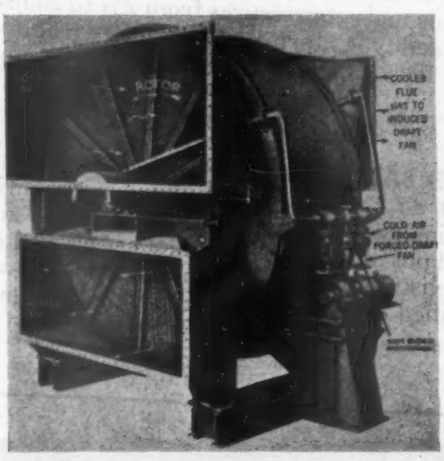


Fig. 14—Regenerative air preheater for horizontal gas and air flow (courtesy Air Preheater Corp.)

flow than they are across the air flow to keep the draft losses on the gas side to a minimum, and to minimize the tendency of the gas passages to foul. Preheaters with undulated-plate envelops are limited to use with clean burning fuels.

Plate air preheaters are usually installed with a forced-draft (cold-air) fan to overcome the resistance to the air flow through the envelops. Stack draft may be used to induce the gas flow through preheaters designed for comparatively low heat recoveries, when gas-outlet temperatures can be kept high to produce the draft and when wide gas spacings can be used to keep the draft loss through the preheater low. An induced-draft (exhaust) fan normally is used for a high-heat-recovery plate air preheater.

Fig. 12 shows a tubular air preheater in which the heat-exchange elements consist of a number of tubes expanded into an inlet and outlet header. The gas passes through the tubes, and the air passes on the outside of the tubes. Tubular air preheaters usually are arranged for more than two passes of the air across the tube elements, and

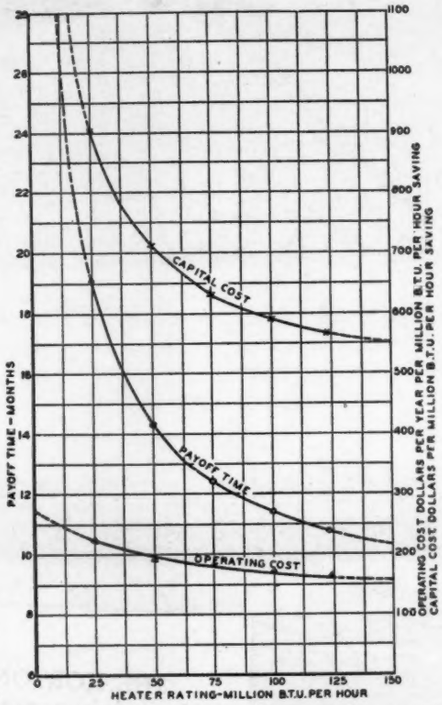

PAYOFF TIME - MONTHS
CAPITAL COST
PAYOFF TIME
OPERATING COST
HEATER RATING-MILLION B.T.U. PER HOUR
OPERATING COST DOLLARS PER YEAR PER MILLION B.T.U. PER HOUR SAVING
CAPITAL COST DOLLARS PER MILLION B.T.U. PER HOUR SAVING

Fig. 15.—Economics of induced-draft plate preheaters with change of capacity—flue-gas temperature, 1,070° F.; preheated-air temperature, 550° F.

may have concurrent or countercurrent flow of air and gas. The air flow shown in Fig. 12 is a combination of cross-flow and a countercurrent *S* flow developed especially for applications with high inlet-gas temperatures and comparatively high air-outlet temperatures to avoid the use of high-temperature-resistant alloys. Cold air entering the hottest gas section of the preheater keeps the mean temperature of the metal at this point much below that which would be obtained if a strictly countercurrent flow were used.

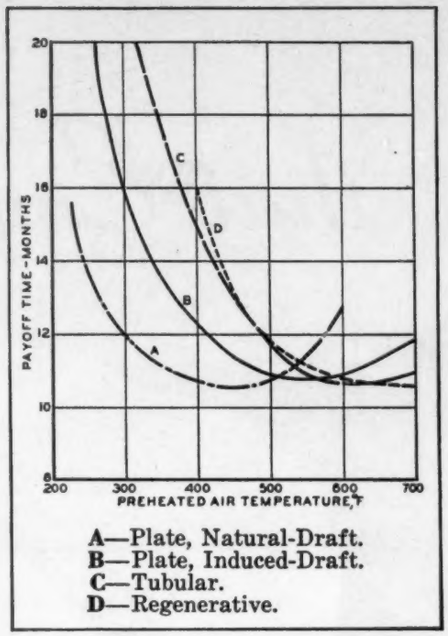


Fig. 16.—Change in payoff time of different types of preheaters with change of preheated-air temperature—flue-gas temperature, 1,070° F.

For a given gas-inlet and air-outlet temperature this type of flow requires more heat-exchange surface, and results in higher draft losses than does the countercurrent flow. However, with strictly countercurrent flow and the inlet-gas and outlet-air temperatures for which the preheater as shown in Fig. 12 is intended, a two-section air preheater as shown in Fig. 13 would be required. The two-section preheater is used with both plate and tubular elements to obtain a closer approach between the temperature of the preheated air and the high-temperature flue gas than can be obtained with a flow through the preheater as shown in Fig. 12.

As a general rule tubular air preheaters are installed with forced and induced-draft fans.

Fig. 14 shows a regenerative air preheater with rotating heat-exchange elements arranged for hori-

(Continued on Page 96)

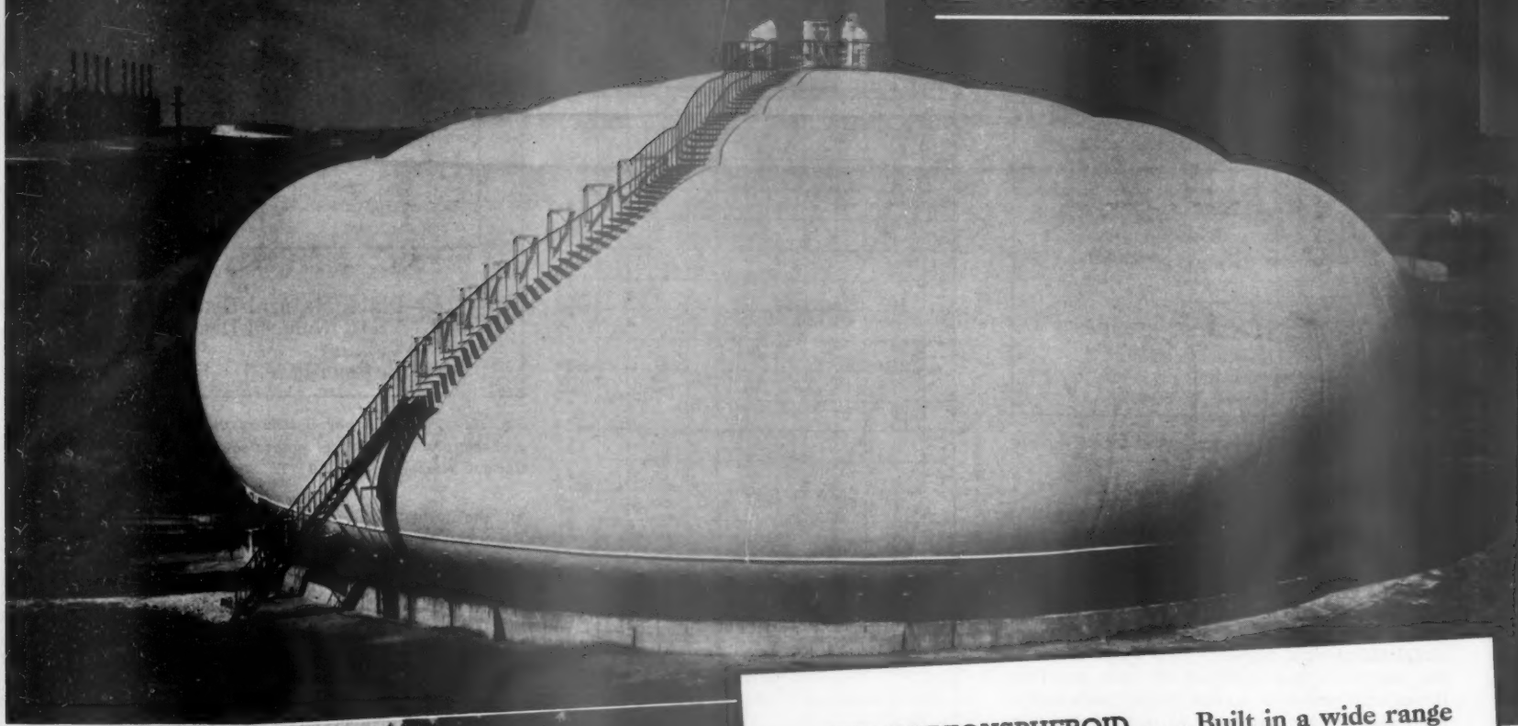
TABLE 3—ECONOMICS OF AIR PREHEATERS AS AFFECTED BY TYPE OF PREHEATER
(Flue-gas temperature, 1,070° F.)

Operating conditions:				
Capacity of heater, millions of B.t.u. per hour delivered to oil	100			
Gas per hour, lb.	181,000			
Air per hour, lb.	173,000			
Temperature of air leaving preheater, °F.	550			
Fuel savings, millions of B.t.u. per hour	31.9			
Savings, dollars per year of 330 days, 24-hour day, at 10 cents per million B.t.u. ($792 per million B.t.u. per year)	25,265			
	Plate preheaters			
Capital cost, dollars:	Natural-draft	Induced-draft	Tubular	Regenerative
Preheater	12,515	10,400	7,095	7,830
Fans and motors	1,140	3,140	4,140	4,615
Duct work, insulation, foundations	*6,900	4,620	4,620	4,650
Total capital cost	20,555	18,160	15,855	17,095
Power requirements, horsepower per hour:				
Cold-air fan	22.5	22.5	32.3	27.5
Exhaust-gas fan	.....	28.8	78.0	48.1
Total power, horsepower per hour:	22.5	51.3	110.3	75.6
Operating cost:				
Power at $60 per horsepower-year	1,350	3,078	6,625	4,540
Insurance and taxes	950	830	715	770
Maintenance and repairs	1,260	5,158	1,250	1,300
Total operating cost	3,560	9,066	8,590	6,610
Net saving, dollars per year	21,705	20,107	16,675	18,655
Payoff time, in years	0.95	0.90	0.95	0.92
Payoff time, in months	11.4	10.8	11.4	11.0

*Includes cost of extra height of stack to obtain draft for preheater.

MODERN STORAGE TANKS

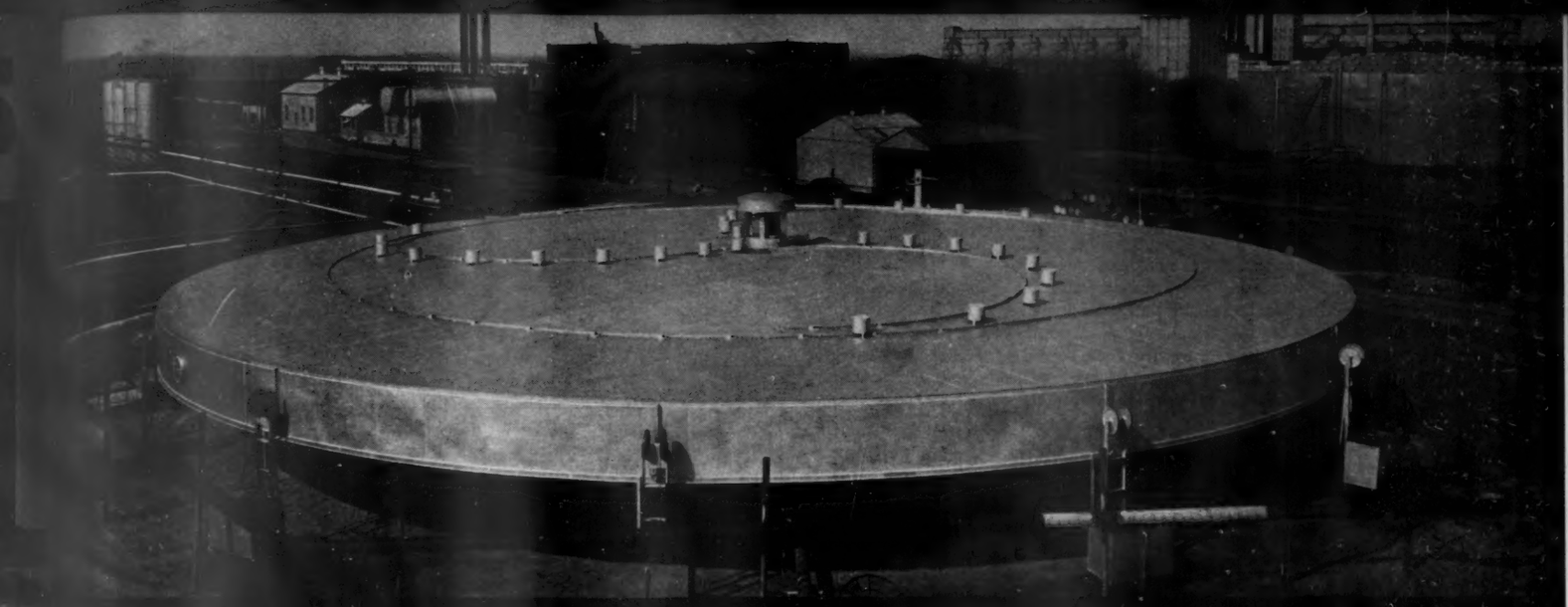
that Emphasize Conservation



THE HORTONSPHEROID . . . Built in a wide range of standard capacities from 2,500 to 120,000-bbls. for pressures up to 30 lbs. per sq. in. Also in larger sizes for handling high test motor fuels at pressures from 2½ to 20 lbs. per sq. in. (The noded type Hortonspheroid shown above has a capacity of 100,000-bbls., designed for 15 lbs. per sq. in. pressure.)

THE WIGGINS BALLOON ROOF . . . Used for all grades of oil that do not boil at ordinary atmospheric temperatures. Primarily recommended where tanks are filled and emptied not more than six times a year. Available for new or existing tanks. (The balloon roof shown at the left is installed on a 30,000-bbl. tank handling gasoline storage.)

THE HORTONSPHERE . . . This modern pressure storage tank is widely used for handling volatile liquids or gases, built in capacities of from 1,000 to 15,000-bbls. or more for 20 to 250 lbs. per sq. in. pressure. Both Hortonspheres and Hortonspheroids are available in *standard* sizes to meet a wide variety of pressure storage requirements— *not just for highly complex operations.* (The four spheres at the right are serving a thermal poly unit at a large refinery.)



because they are designed to *Stop Vapor Losses!*

THE WIGGINS BALLOON . . . Available in comparatively larger capacities, designed to act as a central gas holder in vapor saving systems serving groups of tanks through inter-connected gas-tight piping. (The Wiggins Balloon shown above measures 114 ft. in diam., and is connected to the vapor spaces of three 55,000-bbl. and two 18,000-gal. gasoline tanks.)

THE WIGGINS BREATHER ROOF . . . Widely used on new or existing tanks 60 ft. in diameter or larger that are kept full or nearly full most of the time. This includes standing storage tanks for crudes, gasoline, and other grades of oil that do not boil at ordinary atmospheric temperatures. (The breather roof shown above is installed on an 80,000-bbl. gasoline storage tank located at a pipe line terminal.)

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zontal flow of gas and air through the preheater. . . . The preheater consists of a rotor made up of segments of closely packed undulated plates revolving in a casing provided with gas- and air-inlet and outlet connections. The elements, as they rotate through the heating zone, are heated gradually by hot flue gas to substantially the incoming flue-gas temperature; and, as they rotate through the cooling zone, they are cooled gradually by the air being preheated. As a general rule, a larger proportion of the segments of the rotor is in the flue-gas flow than in the air flow to provide a greater cross-section for the flow of flue gas, so as to keep to a minimum the gas draft losses through the preheater.

Each segment of elements is provided with sealing members to prevent mixing the flue gases and air in adjoining segments of the cooling and the heating zones. The portion of the segment that is not exposed to either the flue-gas or the air streams acts as an additional seal between the flue-gas and the air streams, and as a purging section where the small amount of flue gas or air entrained in the respective segment is dissipated slowly into both streams so that contamination of either stream is practically negligible. . . .

. . . A two-layer construction of elements of the rotor is used when the temperature of the flue gases entering the preheater is above 1,000° F. but below 1,400° F. This construction corresponds to the two-section construction on plate and tubular preheaters shown diagrammatically in Fig. 13. No outside cross-over for the air is required with this rotor construction; therefore, as many layers of different alloys as may be necessary with high gas temperatures to take care of the metal-temperature requirements may be used in this preheater. For example, with an entering flue-gas temperature of 1,600° F., the hottest section of the elements may be made of stainless steel, the next section of 4 to 6 per cent chrome, and the remainder of plain or copper-bearing steel.

With corrugated elements as used in this type of preheater, the draft loss is comparatively high, and both forced and induced-draft fans must be used. The regenerative preheater is particularly effective when high heat recoveries and close approach between high-temperature flue gas and preheated air are desired. With fuels that have a tendency to deposit soot, tar, and sulfur compounds in the cooler portion of air preheaters, this type of preheater, although built of undulated plate elements, will stay cleaner than the plate or tubular type, because the deposits—even if formed in the cooler section of the heating zone—will be burned off when the rotor reenters the hottest section of this zone.

Regenerative air preheaters with stationary heat-exchange elements are not used on petroleum heaters.

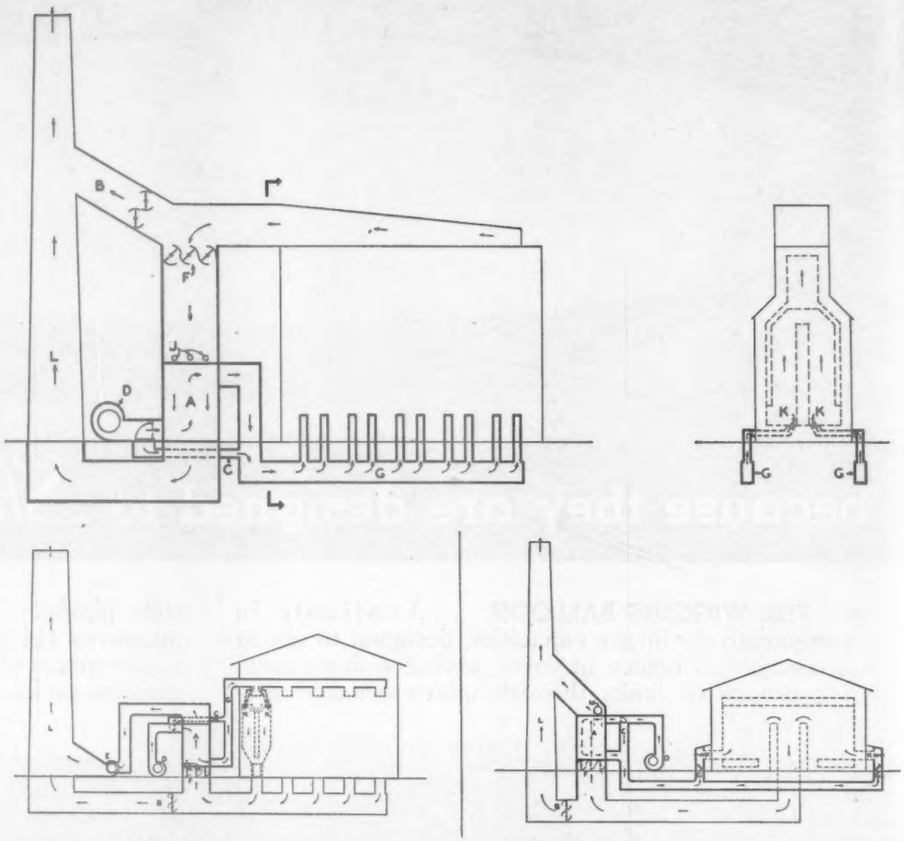

Fig. 17 (top)—Schematic arrangement of recuperative air-preheater installation on heater with top flue-gas discharge and upward firing through bottom of heater. Fig. 18 (bottom, left)—Schematic arrangement of recuperative air-preheater installation on heater with bottom flue-gas discharge and downward top firing. Fig. 19 (bottom, right)—Schematic arrangement of recuperative air-preheater installation on heater with bottom flue-gas discharge and horizontal firing through side walls

Economics of Air Preheaters

The profitability of an air preheater is determined by the relationship between capital expenditure for the air preheater, fans, motors, duct work, insulation, etc., the value of the fuel saved, and the cost of saving this fuel. The value of the fuel saved is the actual sales value of the fuel. Nonsalable fuels, even though of marketable quality, cannot be given any value in determining this relationship, except in so far as they reduce the use of salable fuel consumed in the plant. The cost of saving the fuel consists of the cost of power used by the fans, maintenance cost, repairs, extra supervision, if any, and the fixed charges on capital expenditure. A preheater which produces the greatest net savings and repays the capital expenditure in the shortest time (payoff time) is usually the most suitable for a given installation. Net savings alone, or payoff time alone, is not always the proper criterion in determining the profitability of an air preheater.

Table 3 is a tabulation of economics of four types of air preheaters intended for identical service. The capital expenditure varies from a minimum of $15,855 for the tubular to a maximum of $20,555 for the natural-draft plate preheater. On the basis of payoff time alone, the induced-draft plate preheater is the most profitable of the four, and could be chosen to obtain the quickest return on the investment. However, at the end of the payoff period the natural-draft plate preheater will be saving approximately $5,000 per year more than the tubular preheater, and approximately $1,600 per year more than the induced-draft plate preheater—so that, under the conditions specified and with the short payoff time for all four preheaters, the natural-draft plate preheater is the most profitable.

The profitability of air preheaters of a given type, particularly the relative profitability of preheaters of different types, is affected by the preheater size and the fuel savings desired. Table 4 and Fig. 15 show the change in economics of induced-draft plate preheaters with change of capacity of the heater on which the preheater is to be installed. Table 5 shows the change in economics of natural-draft and induced-draft plate air preheaters for a heater of a given capacity as the temperature of the preheated air is varied.

TABLE 4—ECONOMICS OF INDUCED-DRAFT PLATE AIR PREHEATERS AS AFFECTED BY TYPE OF HEATER
(Flue-gas temperature, 1,070° F.)

Case	A	B	C	D
Net heat input to oil, millions of B.t.u. per hour	25.0	50.0	75.0	100.0
Gas per hour, lb.	36,700	73,400	110,100	146,800
Air per hour, lb.	35,000	70,000	105,000	140,000
Fuel savings, millions of B.t.u. per hour	6.45	12.90	19.35	26.00
Savings, dollars per year of 330 days, 24-hour day, at 10 cents per million B.t.u. ($792 per million B.t.u. per year)	5,108	10,216	15,324	20,432
Capital cost:				
Preheater (including erection)	2,773	4,706	6,450	8,530
Cold-air fan and motor	392	638	821	1,042
Exhaust-gas fan and motor	654	1,022	1,411	1,707
Duct work, insulation, foundations, labor	2,000	2,850	3,500	4,000
Total capital cost	5,819	9,216	12,182	15,279
Operating cost:				
Cold-air fan, boiler horsepower	5.0	11.3	16.5	19.3
Exhaust-gas fan, boiler horsepower	6.5	10.8	15.8	23.5
Total power, horsepower per hour	11.5	22.1	32.3	42.8
Cost at $60 per horsepower-year	690	1,326	1,938	2,534
Insurance and taxes	275	440	580	725
Maintenance and repairs	475	750	970	1,200
Total operating cost per year	1,440	2,516	3,488	4,459
Net savings, dollars per year	3,668	7,700	11,836	15,973
Payoff time, in years	1.59	1.20	1.03	0.96
Payoff time, in months	19.1	14.4	12.4	11.5

On the basis of payoff time, 450° F. is the optimum preheated-air temperature for the natural-draft preheater and 550° F. for the induced-draft. With natural draft, an air preheater for 700° F. preheated air has to operate with such low velocities—due to the limited draft available with the low-temperature flue gases leaving the preheater—that, with the low-temperature differences prevailing under the operating conditions, the preheater becomes unreasonably large and expensive. Therefore, the economics of the natural-draft air preheater is omitted for Case 4 of the comparison. Fig. 16 shows the effect of variation in temperature of preheated air on the payoff time of four types of air preheaters for a heater of a given size. The lowest point in the payoff-time curves coincides with the point of greatest net savings obtained with this size preheater, so that the curves may be used as an indication of the optimum air-preheat temperature for each type. Operation of any of these preheaters much above the optimum air-preheat temperature may make their use unprofitable.

TABLE 5—CHANGE IN ECONOMICS OF PLATE-TYPE AIR PREHEATERS WITH CHANGE OF PREHEATED-AIR TEMPERATURE

	1		2		3		4
Case—	Natural-draft	Induced-draft	Natural-draft	Induced draft	Natural-draft	Induced-draft	Induced-draft
Gas per hour, lb.	200,000		187,000		181,000		173,000
Air per hour, lb.	192,000		179,000		173,000		166,000
Temperature of air leaving preheater, °F.	250		450		550		700
Fuel savings, millions of B.t.u. per hour	13.2		26.0		31.9		39.3
Savings, dollars per year of 330 days, 24-hour day, at 10 cents per million B.t.u. ($792 per million B.t.u. per year)	10,454		20,592		25,265		31,226
Capital cost:							
Preheater (including erection)	4,076	3,536	8,800	7,380	12,515	10,400	17,750
Cold-air fan and motor	1,165	1,165	1,140	1,140	1,140	1,140	1,125
Exhaust-gas fan and motor	.....	4,810	.....	2,465	.....	2,000	1,740
Duct work, insulation, foundations, labor	2,870	3,100	3,600	4,225	4,100	4,620	4,950
Additional height of stack	1,400	.....	1,900	.....	2,800	.....	.....
Total capital cost	9,511	12,611	15,520	15,210	20,555	18,160	25,565
Operating cost:							
Cold-air fan, boiler horsepower	20.0	20.0	22.5	22.5	22.5	22.5	15.5
Exhaust-gas fan, boiler horsepower	.....	28.8	.....	25.0	.....	28.8	26.4
Total power, horsepower per hour	20.0	48.8	22.5	47.5	22.5	51.3	41.9
Cost at $60 per horsepower-year	1,200	2,928	1,350	2,850	1,350	3,078	2,514
Insurance and taxes	425	580	715	700	950	830	1,010
Maintenance and repairs	450	500	900	975	1,260	1,250	1,900
Total operating cost per year	2,075	4,008	2,965	4,525	3,560	5,158	5,424
Net savings, dollars per year	8,379	6,446	17,627	16,067	21,705	20,107	25,802
Payoff time, in years	1.14	1.96	0.88	0.95	0.95	0.90	0.99
Payoff time, in months	13.7	23.5	10.6	11.4	11.4	10.8	11.9

Design and Operating Factors

The operation of an air preheater and its profitability are affected greatly by the design, the manner of installation, and the care used to eliminate—or at least to minimize—the factors which interfere with the efficiency and the continuity of the operation of the preheater under the conditions prevailing in the refinery. The greatest of these factors are corrosion of the preheater elements and fouling of the gas passages of the preheater. The preheater, therefore, should be designed to operate with metal temperatures above those which will result in condensation of the sulfur compounds and the tarry materials in the products of combustion which cause the corrosion and the fouling. With heavy liquid fuels, and with high-sulfur liquid and gaseous fuels, it may be necessary to limit the heat recovery below that which can be obtained with clean-burning nonsulfurous fuels to maintain the temperature of the flue gas and of the elements above the troublesome range.

Even if a preheater is designed for normal operation at temperatures above the corrosion and fouling point, it will be subjected to corrosion and fouling on the startup, unless provided with bypasses to cut the preheater out of service until the corrosion and fouling temperatures have been passed. Many recent air-preheater installations are provided with automatic means to bypass the flue gas around the preheater until the flue gas exceeds a certain minimum temperature and, after this gas temperature has been reached, to admit air to the air preheater only in sufficient quantity to maintain the exit-gas temperature above the desired minimum while the heater is being warmed up.

Although most of the corrosion and a good part of the fouling may be eliminated in this manner, mechanical means may be required to clean the preheater gas passages while the heater is in operation. Soot blowers, scraper chains, and vibration bars are the most common means used. . . .

Figs. 17 to 20, inclusive, show typical chematic arrangements of installations of air preheaters on heaters with different relationship of the point of firing and the point of flue-gas withdrawal. The relationship of flue gas and air flow, and the use of natural or induced draft, are not specific for the arrangements shown, but are included to show the most common arrangements used with any type of air preheater and any type of heater. . . . The pertinent components of the arrangements, as shown in Figs. 17 to 20, inclusive, are marked as follows: *A*, Preheater; *B*, flue-gas bypass; *C*, air bypass; *D*, forced-draft (cold-air) fan; *E*, induced-draft (exhaust-gas) fan; *F*, emergency shutoff damper; *G*, preheated air duct; *J*, soot blower; *K*, burners; *L*, stack; *M*, scraper chains.

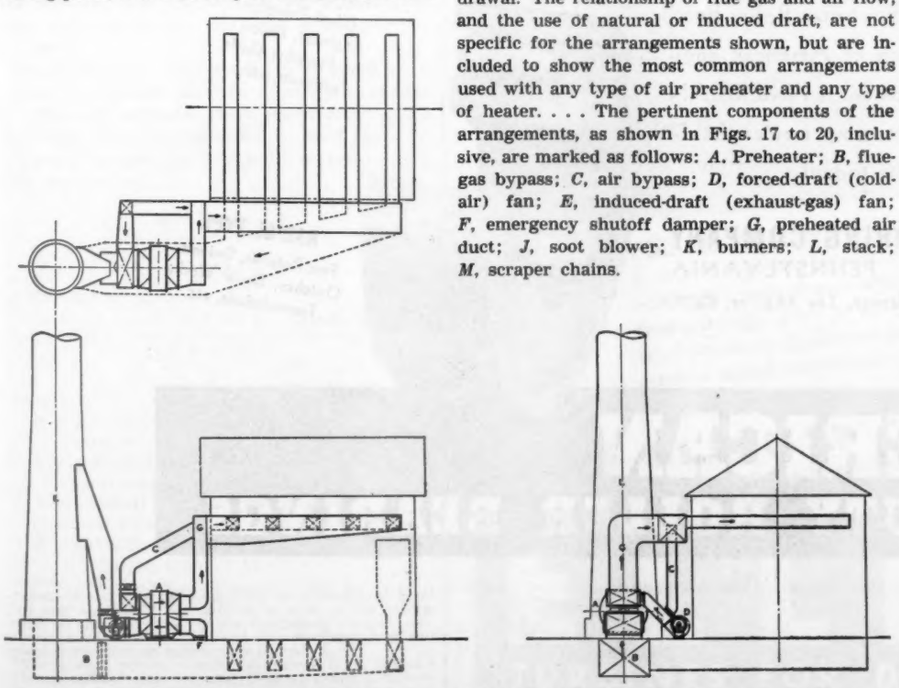

Fig. 20—Schematic arrangement of regenerative air-preheater installation for heater as in Fig. 18

Cathodic Protection

(Continued from Page 86)

A copper-oxide rectifier supplies current to all of the units; and the distribution is controlled by means of variable resistors in most of the junction boxes, which are indicated by small squares on the diagram.

One feature of this installation which is considered important is the method of returning the current. Instead of a single negative connection to the base of one of the towers, an insulated negative return wire was run with the positive feeder and grounded to each condenser individually. This prevents the random circulation of large currents throughout the framework and other operating equipment of the still.

The cooling water is untreated, and has its source in the ship channel just below Houston, Tex. This water is even more contaminated than the former example cited. Sulfates and chlorides predominate.

Insulating Gaskets

Very closely allied with cathodic protection of condensers is the insulation of piping to and from a unit by means of insulating gaskets and bolt sleeves at a flanged connection. This expedient serves to interrupt the normal current flowing in the piping, and thus prevents electrolysis as a result of current entering a condenser and discharging from either the shell or the tubes. However, insulation should be done advisedly, because very often the electrolytic action is localized and cannot be relieved in this manner. Furthermore, serious damage to other adjacent equipment or piping can be caused by improper insulation. . . .

Conclusion

That cathodic protection of condensers and other equipment in water service can be applied successfully and economically as a corrosion-preventive measure is assured in many instances. The current-density requirements under different operating conditions are not yet known definitely. Such variables as the temperature, salinity of the water, composition of the metals present, design of the anode system, and rate of flow of the cooling water are a few of the more important factors influencing the current needed for protection. However, as more installations are made under different conditions, answers to the aforementioned problems should be forthcoming.

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Core-Analysis Interpretation

(Continued from Page 79)

over 2,000 lb. per sq. in., gas-oil ratio is over 1,000 cu. ft. per bbl., the particular sand is a considerable distance below the nearest shale break, the drilling is fairly slow, the mud pressure is considerably above formation pressure and, for this particular sand, low O/W ratios of recovered cores prevail. In contrast, O/W ratios as high as 0.35 have been known to represent wet sands, where many of the aforementioned conditions were opposite to those mentioned here, and the zone was depleted. Even though the effects of all the foregoing contributing factors are known qualitatively, no universally applicable formula for locating wet sands can be given in numerical form. Not even an approximate figure can be given for the critical O/W ratio, as all the foregoing factors also must be considered.

Productivity of sands.

From bottom-hole-pressure surveys on recently completed wells, and from sufficiently complete core analysis, it was found possible to develop an empirical relation between specific productivity index (S.P.I.) and average permeability (K).* The S.P.I. for a well is the production rate in gross barrels per day per pound per square inch differential in mean formation pressure per foot of net sand thickness. The original curve of Pyle and Sherborne (curve *B*, Fig. 1) was based on only nine wells, but the addition of data from some 44 more wells* (curve *C*) has not altered materially the position of the middle part of the original curve (*B*) which is a tribute to the accuracy of the early work. This curve was developed from data for sand intervals of considerable thickness, preferably the whole well, and should not be used on a single thin sand streak. Since the original S.P.I. curve was developed one field has been discovered in which the S.P.I. is very much higher for a given permeability than is usual for California fields. Curve *D* shows the position of the characteristics of this field. Only one explanation appears possible. The saturation pressure is extremely low, which means there is no bubble resistance involved in the bottom-hole-pressure flow tests. This could account completely for the position of curve *D*, and, if it does, we have a rough indication of the relative importance of bubble resistance as compared with water resistance and well muddiness, for this field.

The S.P.I. of a well obviously depends on a number of variables other than merely permeability. The only variables which are involved in the theoretical S.P.I. are permeability, fluid viscosity, and the drainage† and well radii, as can be seen from Darcy's law.

$$Q = \frac{7.08\,hK(P_e - P_w)}{\eta \log_e(\frac{r_e}{r_w})}$$

Or:

$$\text{S.P.I.} = \frac{Q}{h(P_e - P_w)} = \frac{7.08\,K}{\eta \log_e(\frac{r_e}{r_w})}$$

Where:

Q = gross barrels per day
h = sand thickness, in feet
K = permeability, in darcys
r = radius, in feet
e = external edge of drainage area
w = well bore
P = subsurface pressure, in pounds per square inch
η = fluid viscosity, in centipoises
$\log_e$ = natural logarithm (to base e)

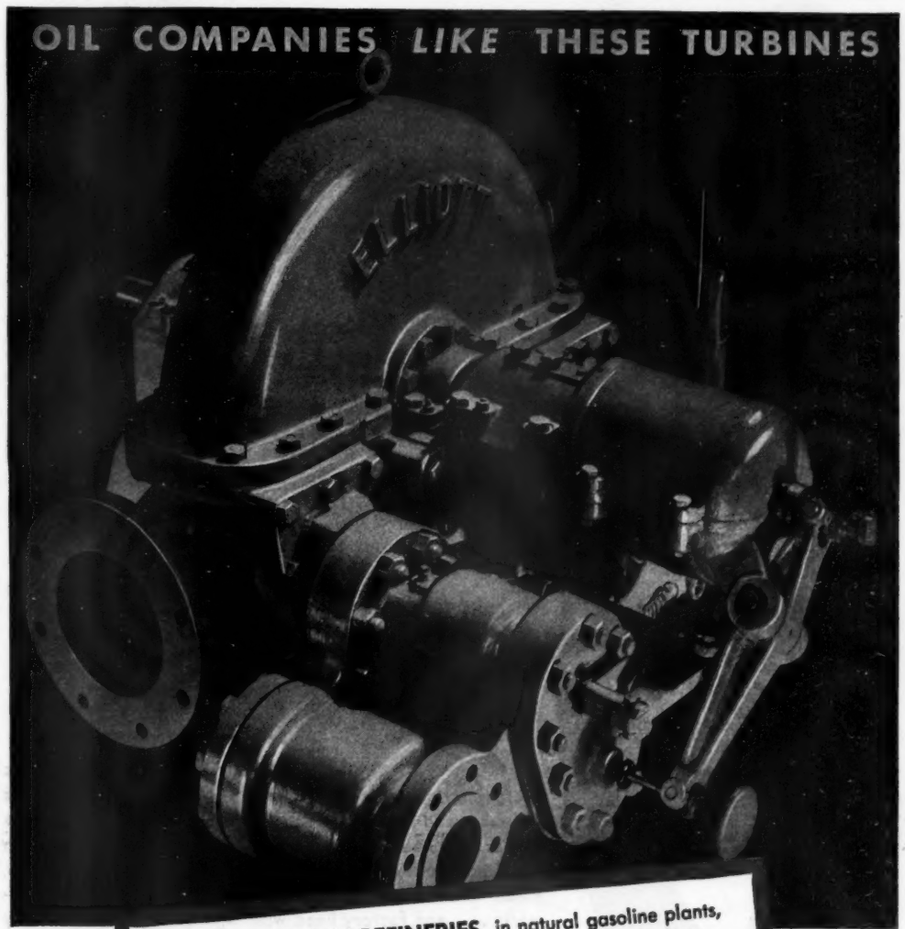
Thus, from Darcy's law alone—because some data are available on fluid viscosity under reservoir conditions,[8] and because fairly good approximations can be made for both drainage and well radii—a theoretical S.P.I. curve should be available for any given well. Such a curve is shown (curve *A*) in Fig. 1, for average conditions (27° A.P.I. oil, 175° F., saturation pressure 1,400 lb. per sq. in., ratio $r_e/r_w = 2{,}000$).

The extreme disparity between theoretical and actual S.P.I. curves is due chiefly to interstitial water and bubble resistance in the sand, and the quality of well completion. Interstitial water, as mentioned previously in the discussion of permeability, decreases the flow of oil for a given pressure gradient, by partly obstructing the flow channels. Bubbles of gas form a similar obstruction,[7] known as "Jamin effect," which may be more severe than the resistance caused by interstitial water. In "quality of well completion" are grouped such factors as excess water flooding near the well bore, mud intrusion into the sand, mud cake, plugged liner perforations, and other impediments to the flow of oil into the well due to unavoidable effects of drilling and completion practices.

It will be noted that, at an average permeability of 15 md., the disparity between the theoretical and actual S.P.I. curves is about 75 : 1, which makes the well performance look extremely poor with respect to Darcy's law expectations. The other deduction from Fig. 1 is that, at higher average permeabilities, the well performance is much better relative to Darcy's law than for tighter sands. This is to be expected, the efficiency of flow improving as its nature veers gradually from

*Contributed data from six California operators, compiled and studied by the author as part of his contribution to the activities of the California district subcommittee on core analysis and electric logging of the topical committee on production technology.

†The author admits readily that there is no definite drainage radius,[9] but, for analytical purposes, a formulation involving r_e is the simplest, and should not lead to highly erroneous results.



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capillary toward hydraulic, with increasing permeability. The extremely poor showing at lower permeability is due to the fact that both water resistance and bubble resistance becomes rapidly more serious as K decreases.

The actual S.P.I. curve is drawn without regard for fluid viscosity or well or drainage radii. It should be possible to draw a family of S.P.I. curves for the different viscosities of oils, and a subfamily of curves for the various radii encountered. However, the effects of well completion, water in the sand, and bubble resistance are so much larger and so irregular as to mask the effects which otherwise could be accounted for properly. A recent attempt to correct S.P.I. data for viscosity did not decrease the spread of the points, as had been expected.

To predict theoretical potentials for a well or zone, the arithmetic average permeability is calculated for the samples which are available for laboratory test, and the S.P.I. is found from the curve for that average K. The gross fluid theoretical potential (T.P.) is then the S.P.I. multiplied by the net sand thickness, and by the static mean formation pressure, or

$$T.P. = S.P.I.\ (h)\ (P_e)$$

As the S.P.I. curve is applied to thinner intervals, particularly when the average K varies considerably from zone to zone, it is found that the sum of the zonal potentials exceeds the well potential. This is one of the weaknesses of the S.P.I. curve which will be discussed hereinafter, under "Problems for Improvement of Core Analysis."

To calculate the water production (cut) for a given zone, after the zonal potential is obtained, some estimate of the water production must be made. The total feet of wet sand must be estimated as closely as possible, and the average permeability determined. Use of the S.P.I. curve is definitely inaccurate, as this was developed for the flow of oil through water-wet sands. One obvious alternative, the use of the product of millidarcys and feet compared with the overall millidarcy times feet for the zone, is also inaccurate. Both these methods will give too low a potential, although the latter is generally more accurate. To calculate the water potential from the millidarcy times feet of wet sand, divide that product by a similar product for the entire zone. This ratio, corrected by the ratio of viscosities of water and oil at the formation temperature and pressure, is then an approximation of the expected water cut. Similarly, the S.P.I. calculation must be subjected to a viscosity-ratio correction. This viscosity correction may be obtained from curves on the effect of both temperature and dissolved gas on oil viscosity and from handbook data on the effect of temperature on water viscosity. If no more applicable data are available on oil viscosity, the correction factors for Dominguez crude oil[8] (34° A.P.I.) may be applied with some success to the viscosities of crudes of other gravities. Fig. 2 shows a usable, very general relation between A.P.I. gravity and viscosity for "dead" or weathered California oils.‡ Fig. 3 herein is based upon Fig. 7 in the reference cited,[8] with a change of coordinates.

A third alternative method of estimating water production involves the direct use of Darcy's law—which is more logical than the S.P.I. curve, as only homogeneous fluids are concerned, yet appears to give too high a potential in the cases tested. For use in Darcy's law, the water permeability should be used, as air always will give too high a value where the sand contains any material (such as clay) which swells in water. Also, a further diminished effective permeability should be used in accordance with the curves of Leverett[15] who shows the effect of oil content on water permeability. This method still gives too high a result, and the interpreter of core data must use his ingenuity when he interpolates between the three types of calculation to fit his particular problems.

Fluid content of sands.

The oil in place in a reservoir and the fraction of it that may be recovered by various means may be calculated from the porosity, oil and water content of the core and some knowledge of the interstitial water. So far, as previously discussed under "saturation," the only knowledge we have of interstitial water is that obtained from tracer-mud coring[9] and oil or oil-base-mud coring. Data on interstitial water, to be usable, are correlated with permeability; and, with considerable latitude may be used on sands other than those tested. This is far from a rigorous or exact procedure, but suffice until better data are available.

As has been agreed tacitly for some time, and recently stated by Muskat,[10] the oil remaining in a core sample at the surface is roughly that which cannot be produced by any physical means short of mining. This is reasonable, inasmuch as the core sample has been subjected to both water drive (contamination during coring) and pressure depletion (during trip to surface). Although these operations are in the opposite order, chronologically, from what usually is done in practice, a water flood before pressure decline probably recovers more oil than if applied later, as pointed out by Moore.[11] There is some question as to the completeness of the water flood during coring; therefore it may be reasonable to assume that, on the average, the core oil is a fair measure of the physically nonrecoverable oil.

To clarify the terminology in the following paragraphs, the bar chart in Fig. 4 has been prepared. In this chart, the overall length of the bars represents the pore volume, and the blank portions at the left represent interstitial water. All three bars refer to the same sand—the differentiation being only between methods of recovery, as

‡Including data furnished by E. G. Trostel and J. E. Sherborne of Union Oil Co. of California.

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illustrated at the left of the bars in Fig. 4.

The gross oil in place in an oil sand obviously is represented by that portion of the pore volume (P) not filled by interstitial water (I.W.), or:

$$\text{Gross oil} = P - \text{I.W.}$$

This gross oil may be thought of as comprising the core oil or physically nonrecoverable oil (O); an amount of oil which is for practical reasons nonrecoverable; a volume which apparently is occupied by oil, but which is lost by shrinkage as the oil loses its gas content; and, finally, the net tank oil. The practically nonrecoverable oil may be broken down further into that lost through bypassing of lenticular oil sands, and that which could be recovered but for economic limitations. It will be noticed that "physically nonrecoverable oil" varies greatly with the recovery method, but that only the "water-drive physically nonrecoverable oil" is labeled "core oil (O)." The core generally is taken after a rather complete water flooding, and the "core oil" thus is determined by this fact.

It may be seen that the method of recovery makes a very great difference in the net tank oil. Let us see how core-analysis results may help in estimating the magnitude of the quantities not recovered.

The physically recoverable oil for conditions of water drive is the gross oil minus the core oil (or physically nonrecoverable oil). This amount is not actually recovered in full—because of sand lenticularity (causing bypassing with any reasonable well spacing), partial gravity separation, and other imperfections in a water drive—but will be given as a physical maximum of recovery:

$$\text{Water-drive recovery} = P - \text{I.W.} - O$$

For estimating the maximum oil which might be recovered by simple pressure depletion, it becomes necessary to assume that the gas-filled space in the core is the same as that which would occur in pressure depletion of the formation, even though there had been contamination and the depletion had been much more rapid than in field production. This is not as bad an assumption as it sounds, because the loss of part of the formation oil by water flushing generally leaves sufficient oil in the core so that, on decrease of pressure, the gas released from solution is able to purge the core about as thoroughly as if there had been no loss of oil by water flushing of the formation. If we speak of core water as W, then:

$$\text{Pressure-depletion oil recovery} = P - W - O$$

An example, using actual data for one California field, may clarify this calculation. A graphical representation of these results is shown in Fig. 4. All percentages in this example are based on bulk volume.

Porosity (P), per cent	22.6
Core oil (O), per cent	2.1
Core water (W), per cent	15.9
Interstitial water (I.W.), per cent	6.5
P — I.W., per cent	16.1
P — I.W. — O, per cent	14.0
P — W — O, per cent	4.6
Formation volume factor	1.7
Shrinkage factor	0.59

Type of recovery—	Gas expansion	Water drive
Porosity	22.6	22.6
Interstitial water	6.5	6.5
Gross oil in place	16.1	16.1
Physically nonrecoverable oil	11.5	2.1
Physically recoverable oil	4.6	14.0
Practically recoverable oil*	3.9	9.1
Shrinkage (41 per cent of above)	1.2	3.7
Net tank oil (bulk volume, per cent)	1.8	5.4
Net tank oil (barrels per acre-foot)	140	418

*Taken arbitrarily as 65 per cent of physically recoverable oil.

In Fig. 4 also are shown possible values for gas-drive recovery. Core analysis does not give data on gas-drive recovery; therefore, the quantities shown are hypothetical. In some instances gas drive may yield greater recovery than water drive.

In a gas sand, the probable amount of liquid oil—either present or likely to be recovered—is difficult to estimate from ordinary cores, although some approximation may be made from pressure-core-barrel data, both as to the amount of gas and its liquid content. In a so-called condensate sand there is generally a very small residual-oil content, giving such low O/W ratios as to suggest wet oil sands. However, the persistent low oil content and low total saturation are evidence of a sand containing a rich gas.

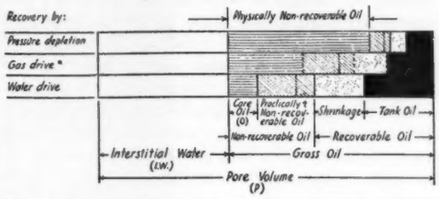

Fig. 4—Terminology relative to reservoir-fluid recovery

Application of Interpreted Core Data

Well completion—Choice of zones to produce.

From the economic aspect, if several zones have been found to contain oil, there are three major considerations to be taken into account in the choosing of the zones to complete: (1) There must be adequate reserve and potential to make completion of the zone worthwhile; (2) there must be a reliable impermeable zone for making the main water shutoff above the sands to be produced; and (3) the production should be substantially dry. One of the most obvious dollar savings which can be made by core analysis is preventing danger of, and expenditure for, formation testing where either reserve or potential or both are insufficient. A recent case in point was an 8-ft. sand at 8,000 ft. which had an apparent gross oil content of more than 2,500 bbl. per acre, but an indicated potential of only 0.8 bbl. per day.

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Frequently, from core analysis, several zones appear to afford nearly dry production; but there may be high potential water zones between these, so poorly segregated from the oil sands that no water shutoff would be successful. The amount of effort to be spent to produce any given sand depends on how valuable the sand appears. It even may be advisable to drill a separate well for each sand. However, if a few minor sands appear above one or two major reservoirs, core analysis can show, for example, that the amount of reserve or potential to be lost by casing off these sands will be easily offset by some years of dry production from the main reservoirs. The upper sands may be brought in later by gun perforating, in the order of their merit, as shown by analysis of cores and the electric log.

One thing which is difficult to avoid, from visual examination of a cored section or the electric log, is completing a well with a gas sand perforated as though it were an oil producer. The wastefully high gas-oil ratio resulting from such a completion can be avoided by setting casing somewhat into the oil sand, so that gas will have some distance to come down into the oil sand before raising the ratio appreciably. Similarly, in differentiating oil from water-producing sands more certainly than can be done from visual inspection, bottom water can be plugged off more surely.

Reserve estimation.

The simple formulas for calculating gross oil in place, pressure-depletion recovery and water-drive recovery have been mentioned hereinbefore. These formulas give the per cent of bulk volume occupied by gross or recoverable oil; and to obtain barrels per acre, the values must be divided by 100, multiplied by the net sand thickness in feet, and by 7,758 (the number of barrels in 1 acre-ft. of space). It should be emphasized again that the resulting figures are physical maxima, and that actual economic recoveries will be lower in all cases by amounts which at present must be left for the operator's policy and experience to determine. The shrinkage factor must not be overlooked, but will not be discussed, as it is not a part of core analysis.

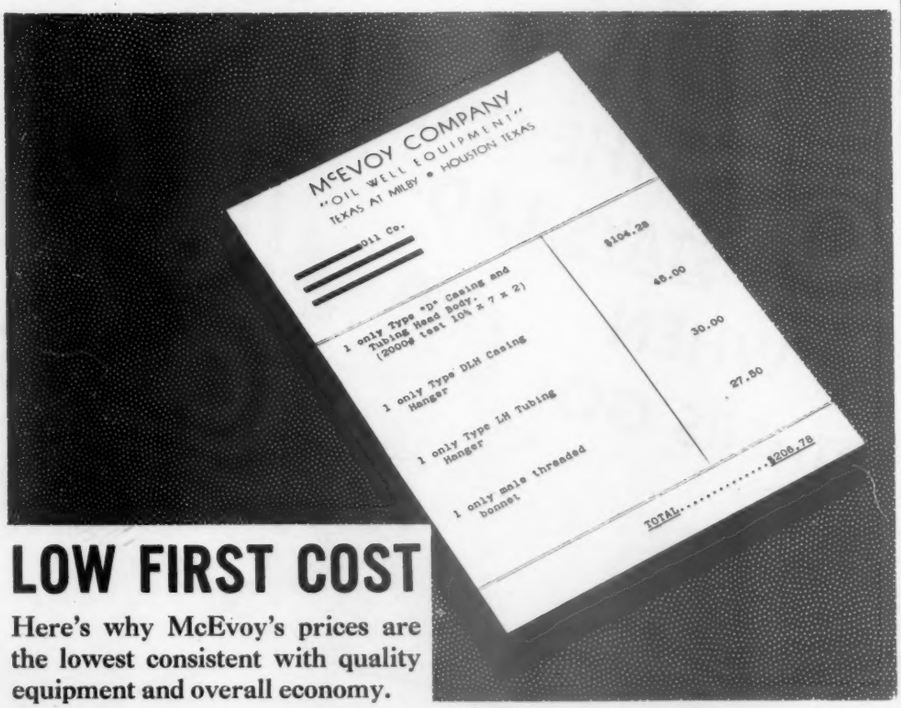
Production problems

One immediate application of core analysis results is the assistance which the calculated potential gives in helping design the production equipment. A small well may allow several economies, possibly in the use of smaller or second-hand equipment. The dollar savings may be considerable.[12]

Because of the many aforementioned factors, a well may not perform as anticipated from core analysis, and still may be normal. However, if maximum production falls below one-tenth of the predicted potential, it is time to look for repairable trouble in the completion. In years past, it has been usual to await the initial-production figures before any quantitative idea of the "size" of a well could be had. Now, however, the approximate "size" of a well may be known before casing is risked; and, if the well makes much less oil than predicted, such cleanout or other changes may be made before moving the drilling equipment as may place the well in a higher allocation bracket.

One of the main applications of detailed core data to production problems is to secondary-recovery technique. Whether or not a water flood is resorted to depends a great deal on the nature of the reservoir. A uniform sand is much better adapted to water drive than a highly lenticular one, and wells can afford to be farther apart. The rate of flooding input depends on tightness of the sand, variation of permeability, separation of sand streaks by shale, and well locations. A tight sand will be bypassed largely by a rapid drive; whereas, if water is supplied at a low enough rate, the tighter sands will be flooded at a rate comparable to that in the looser ones, and the ultimate recovery will be greater. It is still difficult to calculate for any given case just what is the optimum flooding rate for maximum ultimate recovery. A simple flow experiment with several core samples of different representative permeability, properly saturated (both O and W), will allow the determination of the proper pressure gradient to provide the maximum recovery of oil before water bypassing starts. Then there must be a proper balance struck between this optimum rate and economic considerations and the result applied directly to the field. Water flooding is really not quite as simple as that; but, without core analysis it would be enormously more wasteful and expensive. Many capable authors have written on the subject, and core analysis is considered essential by all.

A knowledge of the permeability profile of a well may help greatly in locating water entry when the well goes wet. A high-permeability sand is likely to bring edge water in sooner than a tight sand, particularly if the porosity is low. A high permeability streak near—and not separated by shale from—a wet sand, even though the wet sand is tight, makes a dangerous combination. If the well becomes wet and the water production is greater than the open section could produce (as calculated from core-analysis productivities), then the operator should look for trouble at the shoe or the bottom. There is some possibility that long-time flow of formation water could weaken cementing material, boost permeability and render



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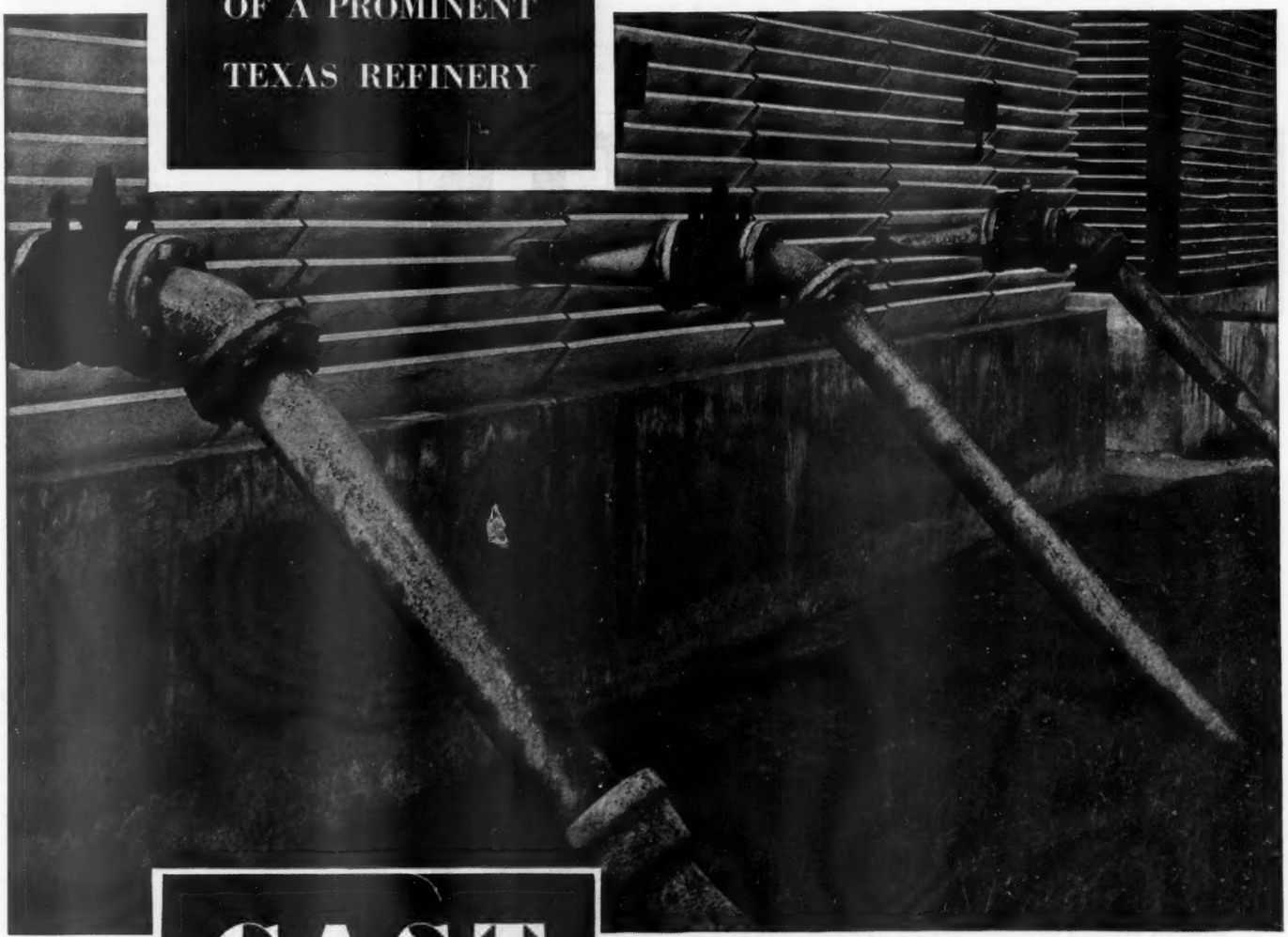

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the core interpretation faulty; but this is rather doubtful.

Another use of core data is to assist in interpretation of bottom-hole-pressure measurements. Briefly, when a producing bottom-hole-pressure profile is not parallel to the static profile, it is difficult to guess where the mean formation-pressure drop should be taken. It should correspond to the mean depth from a fluid-flow standpoint—not necessarily the center of the perforated interval. Inasmuch as the productivity index is calculated directly from this measured pressure profile,[12] a knowledge of the corresponding permeability profile would enhance the accuracy of the work, and avoid errors which might be as high as 25 per cent in the index. This was mentioned briefly by Kantzer and Trostel.[12]

Problems for Improvement of Core Analysis

The following is an attempt to show in some detail how the weaknesses of present-day core analysis interpretation methods may be eliminated. The three main features of this interpretation are undoubtedly the reconstruction of formation-fluid content from the core-saturation data, the distinction between oil and wet sands, and the calculation of well potential from permeability.

Formation fluid content from core saturation.

The main weakness is the lack of universally applicable interstitial water data. The available curves[9 14 16] are widely separated (Fig. 5) so that, for a given permeability, the interstitial water may be 70 or 30 per cent, depending on the location. Thus, for a wildcat, where one does not know which is the proper curve to use, the possible error is very great. Oil coring is troublesome and expensive and, although some engineers think that it improves the quality of the well completion, nevertheless, the process has not been adopted very generally. One way to arrive at the required information is to carry out extensive laboratory tests on actual cores from each important sand to see if some general rule can be made, or if regional correlations are permissible, or whether each sand is a separate problem. If the latter is true, it would still be wise to know it, so that wildcat data will not be too strictly interpreted until the interstitial water characteristic is known.

Another aspect of this same problem has to do with identification of wet sands. There is at present no published rule by which one can tell whether oil or water will flow from a sand of a given permeability containing a given O/W ratio and total saturation. This is all subject to laboratory test, and the results are much more certain to be definite and usable than are those described previously. Because the identification of wet sands appeared to be a promising research, arrangements have been made for carrying it out. This unsolved problem is still with us, and is serious, but has no definite prospects of a solution in another 2 or 3 years.

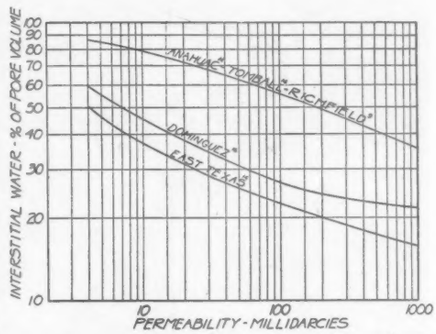

Fig. 5—Interstitial water vs. permeability (Schilthuis,[14] Pyle and Jones, Sherborne[16])

A third problem which exists solely because the core does not contain the true formation fluids is that of calculating maximum gas-depletion recovery. The work mentioned as being already under way, if slightly extended, will cover this problem also. Meanwhile, there is still considerable uncertainty in calculating probable pressure-depletion recovery, because the assumption that the gas volume in the core is the same as would be found in the depleted formation is open to question. In the core, much of the original oil content has usually been replaced by mud fluid, and the only gas available to cause pressure depletion on raising the core to the surface is that dissolved in this small amount of residual oil. Then, too, the liquid available to be forced out of the core by the pressure drop is quite different from the formation mixture. These differences make the assumption open to question; and if there is any such thing as a good guess, the gas volume in the core indicates a higher recovery than will generally be obtained by simple pressure depletion.

The fourth uncertainty is that in calculating maximum water-drive recovery, in which errors in interstitial water content are prominent and also the assumption that core oil is just equal to physically nonrecoverable oil. Again, extension of the work mentioned hereinbefore will answer these questiones, and greatly improve the quality of these various estimates. The extent and complexity of this experimental work are enormous, and complete results cannot be expected for several years.

Productivity from permeability.

As mentioned under "Methods of Interpretation," the relation between Darcy's law S.P.I. and the actual S.P.I. for finished wells gives room for considerable speculation. The 75 : 1 disparity between the two should be broken down

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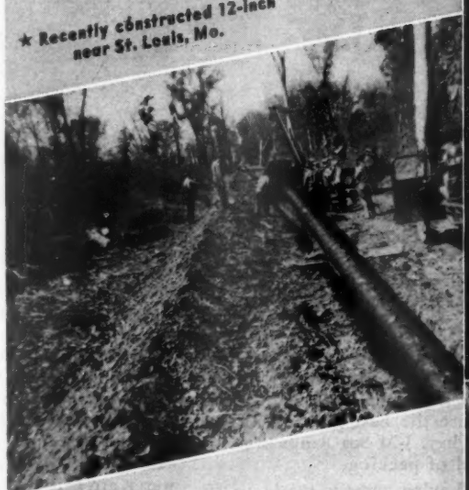

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into its contributing factors. The main difficulty, however, is that in this S.P.I. curve we have a method of analysis whose results vary with the method of using it. Why should not the sum of the potentials of two parts of a zone equal the potential for the whole zone? Why is the curve applicable only to the average of permeabilities over a considerable interval, and not to a single thin sand? How can the disparity be explained?

As mentioned previously, the factors which contribute to the actual index being lower than the theoretical, are water in the sand, bubble resistance, and muddy conditions of the well bore. Experiments easily can determine the effective permeability for various combinations of oil and sand properties, and pressure gradients. These tests can cover both water and gas resistance in the sand, but evaluation of the effect of muddy conditions around the hole is very difficult because of the complexity of the possible conditions. Specific features of the effect of completion practice can be tested experimentally, such as the effect on sand permeability of actual mud-particle intrusion for various pressure gradients and permeabilities.

Reduction of the disparity between practice and theory involves field technique to change the factors causing the disparity. Apparently nothing can be done about the water in the sand. Free gas can be avoided by assuring water drive at the full initial pressure, provided this is above the saturation pressure. The well-completion practice can be improved as better cleaning methods are evolved, or as we learn better how to avoid mudding off the oil sand.

The main problem of potential estimation is one of analysis. The sum of potentials of zones, as calculated from curve *C*, Fig. 1, is not equal to the potential of the zones taken together because the S.P.I. is not directly proportional to K. This is shown in Fig. 1, curve *C* being linear but not at 45° to the coordinate axis on logarithmic paper. The reason for this is partly to be found in the fact that effective permeability differs from air permeability by a larger ratio, the tighter the sand.

There is another interesting approach which involves questioning the assumption of the theoretical Darcy's law curve (curve *A*, Fig. 1), that the fluid flows parallel to the bedding planes. Of course, if each small sand interval is separated from its neighbors by shale breaks, this assumption is justified completely. For the general case—where a continuous sand body several feet thick has a wide variety of permeabilities; when the flow of fluids is due at least in part to a distributed source of pressure (gas expansion, rather than unlimited water drive); when the formation pressure remote from the well is not maintained constant, as by water drive—the flow is definitely not parallel to the bedding planes, but is oblique from the tighter sands both upward and downward into the higher permeability channels because of their earlier depletion. This would make the effective average permeability higher than the arithmetic average. Such a change in average K would assist in the explanation of the nonlinear character of the S.P.I. curve.

Obviously, the thinner the sands of a given permeability ratio, or the greater the ratio for sands of a given thickness, the greater disparity will there be between the arithmetic and effective average permeabilities. The productivity-index formula to account for this situation would probably be so complicated as to be impractical. However, the problem of correctly averaging permeability still exists; and with its solution will come a productivity-index formulation which will be applicable to thick and thin sands, entire well intervals and wet sands.

In Fig. 1 we see that the Pyle and Sherborne curve (*B*) for very low permeabilities indicates a more efficient flow than for the 15 md. sand. which appears least efficient (greatest disparity from theoretical). Offhand, this appears difficult to understand, as there appears to be no logical reason for flow to be hindered less by either

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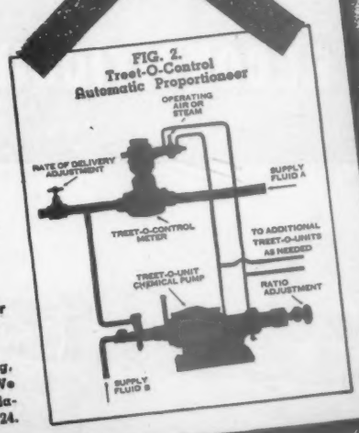

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water or gas bubbles in a sand of 1 md. than one of 15 md. There are, however, some data which tend to corroborate the original curve, besides the two wells which originally defined it. When effective oil permeabilities of water-wet sands are plotted against water saturation, the medium and high permeabilities agree closely with the curve of Leverett,[15] but the very tight sands show a higher effective permeability than the curve indicates, or for a given effective permeability they have higher water saturation—either observation indicating higher flow efficiency. This set of facts does not agree with intuitive reasoning based on the relatively simple concepts of water and gas-bubble resistance and if true, probably is the result of some physical forces which have not commonly been taken into consideration, and which should be elucidated by further experimental work. In any case, the present S.P.I. curve is very valuable for predicting potentials. The foregoing comments are intended not to discourage its use, but rather to encourage further study and improvement of it.

Sand exclusion.

The formulas for excluding loose sand based on its grain analysis have been developed by Coberly.[4] It is known that some wells with coarser gravel than indicated by the formula do operate without sand trouble. It is conceivable that slot width could be based on a 1 or 2 percentile instead of the 10 percentile grain size, with some new rules for bringing the wells in, to avoid slot cutting before the stable bridge (or miniature gravel pack) could be built over each slot. In very low-pressure, low-gravity oil zones, excluding sand by these formulas frequently means also excluding oil. The failure of low-pressure, low-gravity wells in loose sand to produce is a fairly serious matter because of the large number of these wells. The national problem of increasing the economic ultimate recovery depends on increasing the potential of marginally small wells, rather than that of large producers; and if there is any way in which proper interpretation of core analysis can help, this would be one of its more important accomplishments.

Conclusion

Core analysis has reached a stage of development in which it is one of the most definite and useful tools we have for the study of reservoir properties. There are many phases of its interpretation which are only semiquantitative, and which definitely merit further intensive study. It is hoped that this discussion may stimulate experimental work along suggested lines, or bring out alternative methods of interpretation which will lead to greater accuracy and a broader usefulness for core analysis.

Acknowledgment

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Generation of Steam As a Factor in Modern Refinery Heat Economy

By WHEATON W. KRAFT, VALENTINE MEKLER and RALPH H. RIEMENSCHNEIDER
Lummus Co., New York

THE recovery of heat is one of the important factors affecting the profitability of refinery operation. Operations such as distillation, thermal and catalytic cracking, polymerization, solvent refining, dewaxing, and many more processes are dependent upon an outside heat source. With the trend at the present time in the direction of improved-quality motor fuels and lubricating oils, many newly developed processes require still more heat, which means that heat recovery will have not only continuing but increasing interest for the refiner.

The transfer of heat from a hot stream within or leaving a process unit to a cold stream entering the unit has been the basis for most of the heat-exchange equipment at present employed.

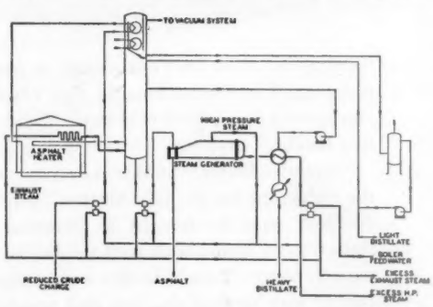


Fig. 1—Flow diagram—asphalt distillation unit

This has led to the widespread use of liquid-liquid and vapor-liquid exchangers to effect fuel savings by reducing the external heating requirements. The extent to which hot streams may be used economically for heating cold streams is determined by comparing the cost of installing and maintaining equipment for heat recovery with the saving in fuel cost which results. There is always a point of economic balance above which the additional cost of heat exchange will exceed the saving in fuel. The same principle can be applied to heat recovery from hot gases leaving direct-fired heating units, because the added cost of heating surface for increasing the efficiency of fired heaters eventually will reach a point where it overbalances the resultant saving in fuel.

In heat exchange between hot and cold streams, the cold stream can be raised economically only to a certain temperature level, so that in most cases additional heat to the cold stream must be supplied by direct-fired heating. Hot streams, after having given up some heat through heat exchange with cold streams, still are at a fairly high temperature level, and, hence, must be cooled to the desired temperature by an external cooling medium, i.e., water. There are also cases in which the maximum temperature to which the cold stream can be heated is limited by the necessity of avoiding vaporization or for other reasons. The net result is that large quantities of heat must be removed by cooling water, with attendant cost of water-pumping equipment, cooling-tower equipment, etc. Because the cooling-water situation at a great many refineries is far from ideal, the cumulative effect is higher operating cost. Coincidental with added cooling-water requirements is the need for more steam for pump drives and sundry process uses. One solution of the situation outlined is to recover much of the heat which otherwise would be dissipated to cooling water or to stack gases by employing it for the generation of steam.

This practice is not new, but in recent years many developments and modifications have been made which have increased its value and usefulness. The more general acceptance of steam generation for heat recovery has been accelerated by the increased temperature and pressure level and high internal cycle employed in thermal processes, and also by the many new catalytic processes which require the removal of a great amount of excess heat created by process requirements. The trend of increased temperature levels and excess heat available in modern refining practice leads to a greater demand for both cooling water and steam, which makes heat recovery by steam generation most attractive.

For refinery units of large capacity, a factor which must be considered in intelligent design is the need for a certain amount of flexibility as regards charging material and operation for market requirements. There are a few locations wherein a constant supply of uniform-quality crude oil can be counted on, but a great many

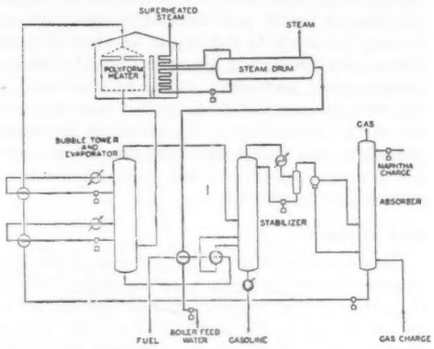


Fig. 2—Thermal polymerization, polyform or gas reversion units

refiners must process different crudes in various proportions, depending on the source of crude supply and changes in market conditions. For a combination selective thermal cracking unit, this may mean a considerable increase in light-end cracking when a paraffinic-type crude with high gasoline content of low octane number is available or, on the other hand, it may shift the cracking load to viscosity breaking and heavy-oil cracking if a heavy-naphthenic or asphaltic-type crude must be run.

Such a change in cracking load has a corresponding influence on the heat-recovery system of such a unit and, rather than provide for flexibility by the installation of considerable over-surface in heat equipment on the several hot streams which will vary the most, it has been found advantageous to install a steam-generating system having multiple elements that allow the desired

A.P.I.

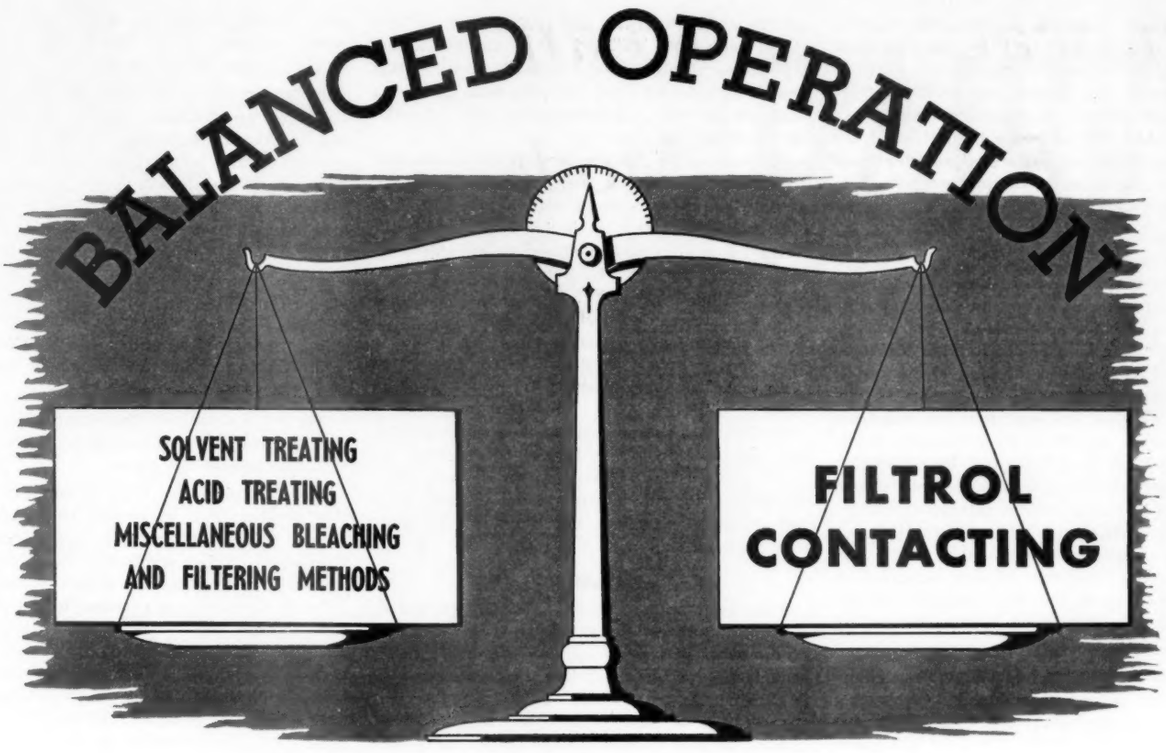
This paper discusses the recovery of heat in various refinery operations by utilizing it for steam generation. With the advance in modern thermal processes which employ increased temperature and pressure levels and also in modern catalytic processes, the removal of large amounts of excess heat existing in the system by using this heat for generating steam offers a simple, flexible, and economical solution, especially when cooling-water and steam conditions are not satisfactory.

Aside from employing heat exchangers on a number of hot streams available within the process system, the installation of surface in the convection section of oil heaters under certain conditions has been employed successfully for steam generation, particularly on heaters requiring expensive alloy material for tubes and fittings in oil service. Steam generation and its effect upon selection of pumps and reduction in utilities consumption are outlined.

The selection of the type of steam-generating equipment to be employed depends on the number, temperature, and pressure level of various hot streams available from the particular operation, and also upon the cost of tubes and headers required in the oil heaters. Typical installations of steam generation as incorporated in asphalt distillation, thermal polymerization, and combination cracking units are discussed and illustrated by flow diagrams and tables.

Paper was presented before the group session on refining at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22.

R. H. Riemenschneider *W. W. Kraft* *Valentine Mekler*



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flexibility. These elements can be made uniform in size and so manifolded that they may be shifted from one hot stream to another as shifts in heat load occur. The overall heat recovery from such a system normally is reasonably constant in spite of considerable variation in individual hot streams, so that the over-surface requirements can be kept to a minimum in comparison with heat exchange between hot and cold oil.

In addition to shell-and-tube type units, the installation of steam-generating surface in the convection section of direct-fired heating units has been employed successfully and economically. Tubes and fittings for oil service often are of expensive alloy material for withstanding the temperature and pressure conditions encountered; and, as higher heat absorption rates are obtainable from radiant or semiradiant tubes than from convection tubes, any alternate method of recovering useful heat from hot gases by convection tubes becomes attractive. In some cases the savings effected by using radiant instead of convection tubes for oil service have paid for the cost of installing steam-generating surface in the convection section. The effect of any variation in oil-heating load upon the heat available in hot gases is absorbed readily by a steam-generating coil in the convection section.

Selection of the type of steam-generating equipment for heat recovery depends on the steam characteristics desired and on the particular operation under consideration. This is influenced by the number and temperature and the pressure level of various hot and cold streams, their respective heat transfer rates and fouling factors. Most steam generators installed are of the circulating type rather than the once-through type, so that heat is transferred from the tube wall through a boiling-water film accompanied by high velocities on the water side.

This mechanism makes possible the economical recovery of heat from such hot streams as tar, asphalt, and other residual oils wherein fouling of heat-exchange surface by the hot medium is rapid. Inasmuch as fouling is confined to one side only, the foul medium can be put through the tubes and cleaning made easier. In case sufficient surface is indicated to warrant installing several units, cleaning can be carried out easily during operation by bypassing the fouled unit, cleaning it in place, and subsequently putting it back in service.

To illustrate the potentialities of steam generation, we shall consider typical installations incorporated in such refinery operations as asphalt distillation, thermal polymerization or polyforming, small-scale cracking, and large-scale combination cracking.

Asphalt Distillation Unit

Steam-generation equipment added to an asphalt distillation unit can be taken as a typical example of the simplest type of system. Inasmuch as the asphalt product is normally a large percentage of the reduced-crude charging stock, and as this stream is at a high temperature level, a large amount of heat is available for generation is one stream. The poor overall heat-transfer coefficient between asphalt product and reduced-crude feed, plus fouling conditions which prevent maintenance of clean transfer rates, also makes generation of steam attractive.

A process factor favoring steam generation in this type of distillation unit is the positive control of the cooled temperature of the asphalt stream. With a water-cooled coil in such service, there is always the danger of too much cooling, with consequent plugging of the coil by solidified asphalt. With boiling water as cooling medium, the cooled-asphalt temperature is controlled automatically within a few degrees. A steam-generating system fits in well with an asphalt plant, because the steam requirements for this type of plant are quite large—including, besides steam for pumps and process steam, steam for tank heating and steam tracing of asphalt lines.

Fig. 1 is a simplified flow diagram of an asphalt distillation unit incorporating generation of steam from the hot-asphalt stream.

The most desirable type of generator unit for this service is a horizontal shell-and-tube unit of the kettle type with the hot asphalt flowing through the tubes and steam being generated in the shell. The generator pressure is determined by the existing steam pressure of the plant or by the pressure requirements of the unit. The feed water is heated to approximately the generator temperature from a smaller stream before it goes to the generating unit, so that the latter supplies only the latent heat of vaporization. A liquid-level controller installed on the kettle shell for controlling the input of feed water and a pressure-control valve for controlling the pressure of

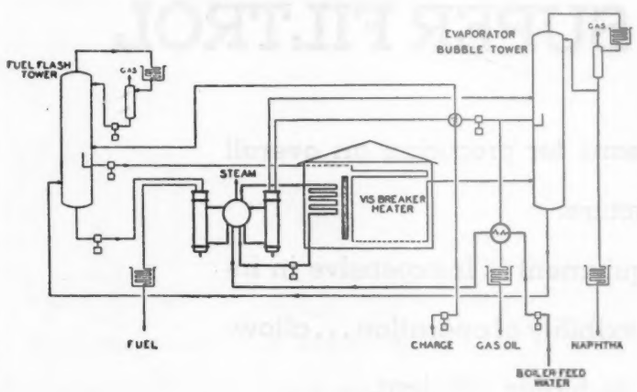

FIG. 3

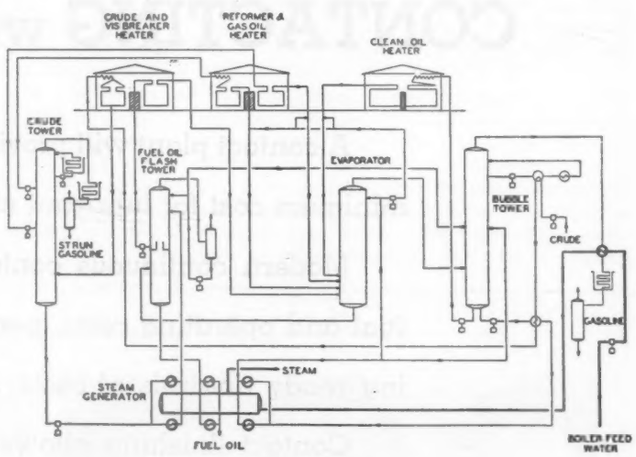

FIG. 5

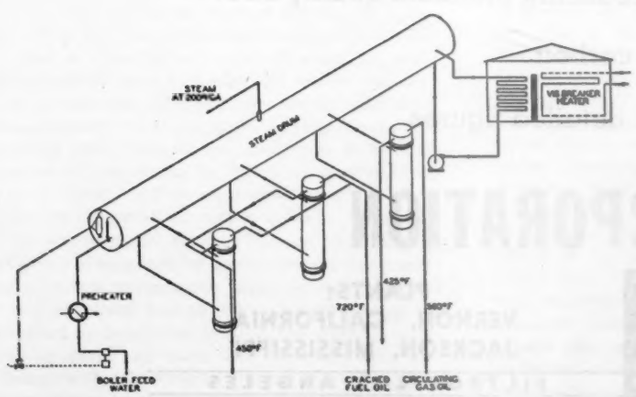

FIG. 4

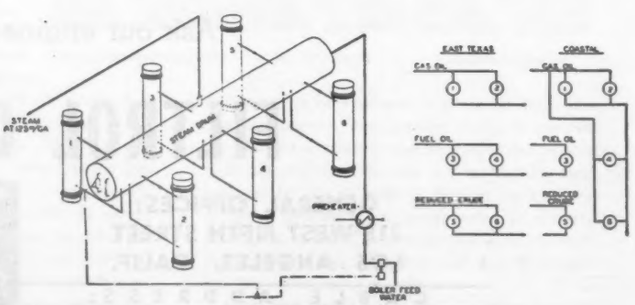

FIG. 6

Fig. 3—Flow diagram—viscosity-breaking unit. Fig. 4—Steam diagram—viscosity-breaking unit. Fig. 5—Flow diagram—selective cracking unit. Fig. 6—Steam diagram—combination cracking unit

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steam generated provide all the necessary instrumentation for the system described.

Thermal Polymerization, Polyform or Gas Reversion Units

Thermal polymerization, polyform or gas reversion units afford a good example of the type of plant characterized by high temperatures and high pressures in the fired heater coils, but with less waste heat in circulating streams at temperature levels attractive for steam generation than is the case in conventional thermal cracking units.

TABLE 1—STEAM-GENERATION DATA FOR LARGE COMBINATION CRACKING UNIT

(Note: Steam generated at 125 lb. per sq. in. gage)

	East Texas crude	Coastal crude
Gas oil:		
Quantity, lb. per hr.	230,000	351,100
Heat removed, B.t.u. per hr.	10,700,000	31,220,000
Cooling range, °F.	485-425	560-425
Steam produced, lb. per hr.	11,800	34,400
Number of bundles	2	4
Fuel oil:		
Quantity, lb per hr.	100,700	65,600
Heat removed, B.t.u. per hr.	17,300,000	10,000,000
Cooling range, °F.	710-415	700-400
Steam produced, lb. per hr.	19,100	11,000
Number of bundles	2	1
Reduced crude:		
Quantity, lb. per hr.	136,600	67,000
Heat removed, B.t.u. per hr.	16,450,000	8,370,000
Cooling range, °F.	605-420	590-405
Steam produced, lb. per hr.	18,100	9,200
Number of bundles	2	1
Total steam produced, lb. per hr.	49,000	54,600

Fig. 2 shows a simplified flow diagram of such a process unit. Cold charge is preheated readily by heat exchange against circulating hot streams of the combined evaporator and bubble tower, so that convection-section heating is not attractive.

Because surface in the radiant section of an oil heater will absorb approximately three times the amount of heat per square foot as surface in the convection section, the saving in expensive tubes and fittings by putting all surface for oil heating in the radiant section usually will pay for carbon-steel tubes and fittings installed in the convection section for steam generation. A portion of the convection section sometimes is utilized for steam superheating as well as for steam generation.

The steam-generating system for this type of unit consists of a separating drum, heater tubes in the convection section, a water-circulating pump, and the necessary instruments. Water is circulated from the bottom of the drum through the heater tubes at a rate considerably higher than the rate of generation in order that at no time will there be complete vaporization in the tubes. The mixture of steam and water is returned to the drum, where the steam and water are separated by means of baffles and a dry pipe. The feed water is preheated practically to the separating-drum temperature by exchange with an available hot-oil stream. The instrumentation required consists only of means for controlling water circulation, feed-water supply, and steam pressure.

With this arrangement, considerable steam is generated at low cost, because the total investment cost of the heater, including steam-generating tubes, is no higher than if oil alone were heated. The amount of heat recovered by steam generation and superheating with this arrangement is about 25 per cent of the heat absorbed by oil, and is enough to operate the main charge pumps of the plant. Steam at pressures up to 450 lb. per sq.

TABLE 2—STEAM-GENERATION DATA FOR TYPICAL REFINERY UNIT

	Type of unit			
	Asphalt distillation	Naphtha polyform	Small cracking	Large combination cracking
Flow diagram	Fig. 1	Fig. 2	Fig. 3	Fig. 5
Capacity, bbl. per day	4,000	13,000	5,000	22,000
Steam pressure, lb. per sq. in., gage	120	150	200	125
Steam from hot streams, lb. per hr.	4,500	12,000	10,600	49,000
Steam from convection tubes, lb. per hr.	.....	*48,000	7,400	.....
Total steam generated, lb. per hr.	4,500	60,000	18,000	49,000
Total steam requirements, lb. per hr.	3,500	48,000	8,000	58,000
Total electricity requirements, kw.	30	400	85	1,100
Total heater duty, millions of B.t.u. per hr.	13.3	200.0	45.5	245.0
Heater steam generation, per cent of total heater duty	.....	30.0	20.0	.....
Hot-oil steam generation, per cent of total heater duty	40.0	7.0	28.0	24.0
Reduction in cooling-water requirements (30° F. rise), g.p.m.	360	950	850	3,900

*100° F. superheat at 125 lb. per sq. in.

TABLE 3—ECONOMICS OF STEAM GENERATION

	Type of unit			
	Asphalt distillation	Naphtha polyform	Small cracking	Large combination cracking
Flow diagram	Fig. 1	Fig. 2	Fig. 3	Fig. 5
Additional investment, dollars	3,980	32,600	14,250	42,200
Savings in water circulation, dollars per month	150	420	360	1,680
Value of steam generated, dollars per month	840	11,200	3,400	9,200
Cost of additional fuel, dollars per month	.....	1,500	600	.....
Net return, dollars per month	990	10,120	3,160	10,880
Payoff, months	4.0	3.2	4.5	3.9

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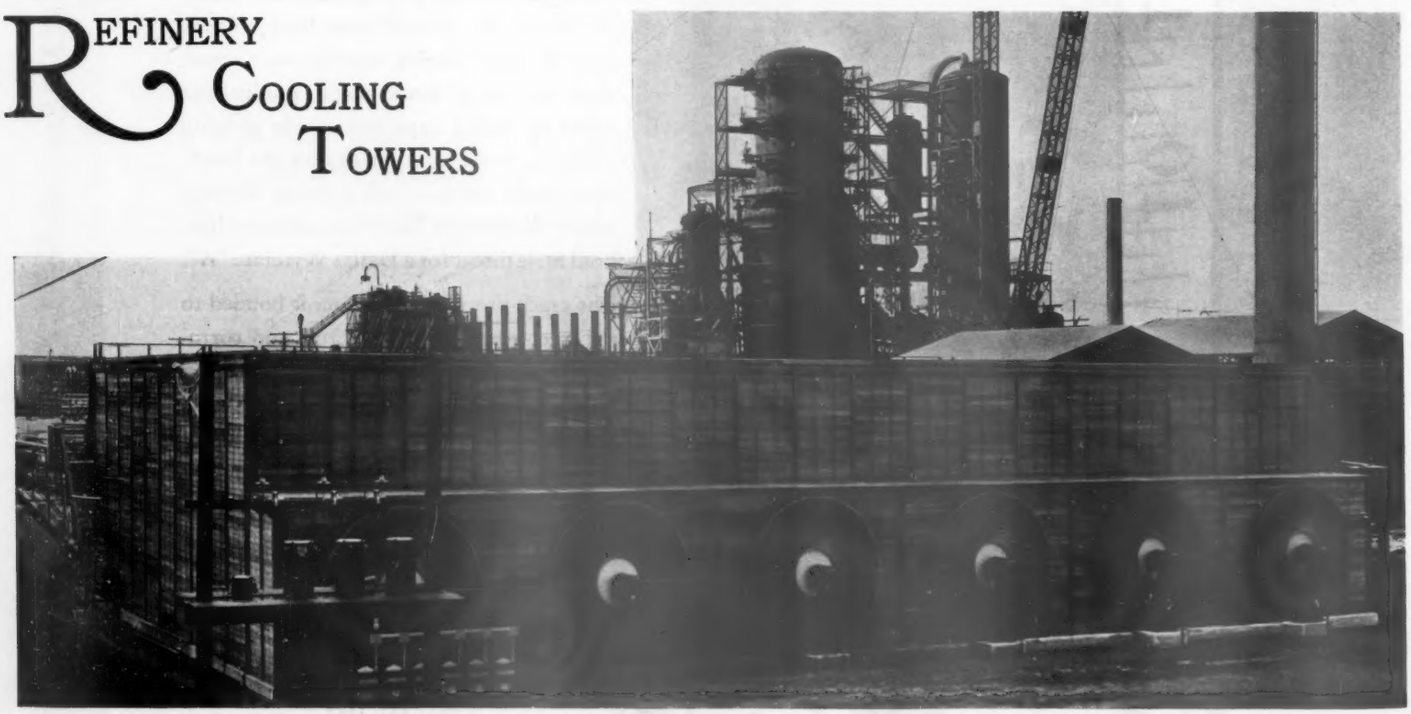

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in. gage, has been generated in a system of the type shown.

Small Cracking Plant

A small cracking plant can be taken as an example of an installation with more than one source of waste heat available in hot-oil streams. Also, depending upon the particular case, it may or may not be advisable to include generation from tubes in a convection section of a heater. Inasmuch as a small cracking plant generally is designed for only one charging stock and has little flexibility, both the plant itself and the steam-generating system must be simple.

There are several possible oil streams available at high enough temperatures and of such size that steam generation is attractive. If the feed to the unit is crude oil, a fuel-oil stream of from 15 to 40 per cent of crude is available at a temperature of from 650 to 700° F. The circulating gas-oil stream used for quench and reflux varies greatly with the type of process unit, but is often the largest hot stream available. This stream is at a temperature of about 700° F.; and, after having been used for crude preheat, is still available at a temperature of 550 to 600° F. for steam generation.

Fig. 3 shows a simplified flow diagram of a small-capacity viscosity-breaking unit. As the charging stock in this case is hot reduced crude, there is no liquid preheating problem, and the total heat of both circulating reflux and fuel-oil streams can be used for steam generation.

Fig. 4 shows the general arrangement of the steam-generating system itself. This particular installation includes steam generation in the convection section of the heater as well as from the hot-oil streams. The equipment includes a horizontal separating drum, a water-circulating pump, tubes in the convection section as described previously, and vertical shell-and-tube units attached to the separating drum. The hot-oil streams are circulated through the tubes, with boiling water circulating through the shell side of the bundles shown. Feed water, which has been preheated by a small hot stream, is fed into the drum to maintain liquid level. Such a system normally produces steam at pressures of 150 to 200 lb. per sq. in. If desired, steam may be generated at one pressure from the hot-oil streams and at a higher pressure from heater tubes—which arrangement, of course, requires two separating drums and two sets of instrument control.

Large Combination Cracking Unit

A large-capacity combination cracking unit usually is designed for flexibility to meet variations in charging stocks and market conditions. Several sources of waste heat are available in liquid streams at temperature levels suitable for generation of steam. The fired heating units are large; and, as some of the heater charge streams are at high temperatures, steam can be generated also by employing the convection sections of these heaters. Reduced crude is available to the extent of approximately 30 to 60 per cent of the crude charge at a temperature of 550° to 600° F., fuel oil to the extent of 15 to 40 per cent at 650° to 700° F., and circulating gas oil at approximately 500° to 600° F. These are approximate levels after allowing for economical crude preheating.

The elements of such a modern selective cracking unit are shown diagrammatically in Fig. 5. As will be seen, there are six coils for crude preheating, reforming, viscosity breaking, and virgin and recycle gas-oil cracking. The process flexibility provided by such an arrangement makes it essential to provide similar flexibility in the steam-generating system. This has been accomplished by an arrangement such as that shown in Fig. 6, which is a unique development of the Lummus Co. The combination of steam separating drum and attached vertical shell-and-tube bundles

is similar to previously described systems. However, by providing multiple units and a system of manifolded hot-oil piping, as shown in Fig. 6, it becomes possible to compensate for great variations in hot-oil stream quantities and temperatures without having to install excessive shell-and-tube surface.

The advantage of such a multiple-unit system clearly is indicated by the operating data of Table 1. We find that, in spite of the variations shown, the total amount of steam generated is relatively constant and the surface installed is operating at good efficiency. Although the actual installation from which these data were obtained did not include steam-generating tubes in the heater, approximately 50,000 lb. per hour of additional steam could have been produced.

The division of steam-generating equipment into a high and a moderate-pressure system may be worthwhile for this size installation, depending upon the circumstances. Also, in cases wherein very rapid fouling occurs or wherein variations in hot-stream flow and temperature are even greater than shown, the use of properly manifolded spare shell-and-tube bundles should be considered.

Conclusions

We have indicated in this paper some of the many applications for steam generation in refinery operations, all of which were the result of studies made to improve heat economy. What this means in terms of utilities requirements is shown by Table 2. For example, we find that the asphalt distillation unit is more than self-supporting as regards steam for pumps, vacuum jets, and fuel-oil atomization—with ample exhaust steam available for process use. The naphtha polyform unit, with high-pressure heater charge pumps can depend upon a large and uniform steam supply, with most of this steam at 100° F. superheat. . . .

As can be seen from Table 2, the quantity of steam generated amounted to 60,000 lb. per hour for this unit. Conditions for the small cracking unit are similar to those for the asphalt distillation unit. The economics of electric power and steam cost dictated the choice of drivers for pumps in the large combination unit. The amount of steam generated proved sufficient for normal operation, although a demand on the refinery boiler plant of 9,000 lb. of steam per hour is indicated as a maximum condition.

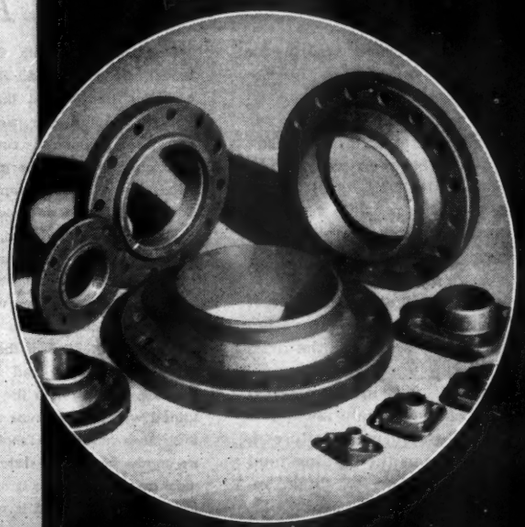
The reduction in cooling-water requirements for all examples also merits attention. If we note the relationship of heat recovered by steam generation from hot streams to the external heat added to oil, we can obtain a measure of reduced cooling-water requirements, because external heating requirements and external cooling requirements are approximately the same. Steam generated from hot-oil streams, expressed as per cent of the total heater duty, may be as high as 40 per cent. as indicated by Table 2.

Table 3 shows the economics of steam generation applied to refinery units taken as examples. Under the heading "additional investment" is included the cost of all extra equipment required, such as surface in heaters, shell-and-tube equipment, drums, instruments, pumps, piping, etc.

The value of steam is taken as 26 cents per 1,000 lb.; of fuel, as $1 per barrel; and of water, as 1 cent per 1,000 gal. The indicated payoff period is seen to be short, ranging from 3 to 4½ months.

We have shown the value of steam generation as a means of recovering waste heat from liquid streams and hot furnace gases for a number of typical refinery operations. We have discussed the flexibility and process control obtainable from such installations, and the factors which determine the choice of the specific type of equipment employed. It should be noted that operations in many existing plants can be made more economical by heat recovery through generation of steam

Identification



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Pressure-Core Analysis

By J. J. MULLANE
Carter Oil Co., Tulsa

A.P.I.

Data obtained with the Carter pressure core barrel are presented. It is shown that a more complete analysis of the core now can be obtained, and that the usefulness of core analysis has been extended considerably. Gas-oil-ratio data obtained with the pressure core barrel have been shown to be in agreement with the production gas-oil ratio as determined in the field.

It has been found that, in addition to gas, both oil and water are contained in cores, even though taken from wells that produce no water. A correlation has been observed between the oil produced from cores taken in a given horizon and the initial potential of the well. A part, at least, of the water produced has been shown to be connate water. With the more complete data obtained with the pressure core barrel, it is believed that more reliable estimates of reserves now can be made from core data. Information as to the mechanism by which cores are polluted by water from the drilling mud is given. Evidence is given to show that two types of invasion are operative; these are: a vertical invasion ahead of the bit, and a radial invasion of the core.

Paper was presented before the Division of Production at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.

CORE samples usually are taken from formations believed to contain oil or gas. From the analysis of such samples it is desirable to ascertain: (1) If there is oil or gas present; and (2) how much oil, gas, and water there is in the pore spaces of the rocks. In other words, it is necessary to evaluate oil-field properties for the purpose of commercial exploitation or, in the case of property under development, to estimate reserves. Another use of such data that is of importance is in old developed fields. In this case it is often desirable to core between wells in order to determine whether the well density used was sufficient to give the best possible recovery. The importance of these problems is well known to the petroleum industry.

The ideal solution to these problems would be to obtain a sample of the formation of interest in its original state. However, due to the invasion of the formation sample by water from the drilling fluid during the drilling operation, the sample which actually is obtained is not in the original condition, but has been changed materially. The first step, then, in the analysis of cores is to estimate the amount of water from the drilling mud that enters the core, and, further, to obtain information on the nature of the disturbance that occurs during and after this invasion.

Core drilling with a conventional core barrel does not permit sufficiently complete observations properly to evaluate a core sample. As the core barrel is brought up the hole, the pressure is reduced—and all the gas in the sample is lost, and with it some of the liquid contents of the core. All that is left are the residual liquids, i.e., the dead oil and water. The water is a mixture of the original formation water and water from the drilling mud, and nothing is known of what occurred either during the drilling process or during the time the barrel was being brought out of the hole. From such meager information as this, it is very difficult to reconstruct any reasonably accurate picture of the coring process or of the formation in its original state.

The pressure core barrel takes a core essentially in the same manner as a conventional core barrel; but, upon completion of the drilling operation, the core barrel is sealed by means of valves, and the core and its fluid contents are brought to the surface under a pressure approximately equal to the hydrostatic head of the drilling mud at the coring depth. Thus we are in a position to measure not only the amounts of the residual liquids, but also the gas released, and the oil and water which are produced from the core under the influence of the expanding gas.

From these more complete data, a more reliable estimate of the original contents of the formation can be obtained. It is the objective of this paper to present the data obtained with the Carter pressure core barrel, and to discuss the conclusions that may be drawn from them.

Core Drilling

From a mechanical point of view, coring with the pressure core barrel is the same as with any conventional type of core barrel, and similar results are obtained. The core recovery in Illinois with the new pressure core barrel averages 80 per cent of the core cut. This core barrel cuts a core 2⅝ in. in diameter, and 8 ft. 6 in. in length. With respect to its special functions, the operation of the pressure core barrel is entirely satisfactory. Pressure is recovered in 90 per cent of the runs. The operating conditions observed are similar to conventional practice. Rotary-table speeds of from 50 to 70 r.p.m. and drilling weights of from 10,000 lb. to 12,000 lb. are used. Pump pressures of from 200 to 500 lb. per sq. in. have been used. This was equivalent to a flow of from 250 to 350 gal. per minute. As a general practice, however, all the variables of the drilling operation were kept as nearly constant as possible.

On all wells selected for coring with the pressure core barrel, the attempt was made, in so far as possible, to maintain uniform properties in the drilling mud. As a general practice, the drilling mud, before coring, was conditioned with Aquagel, and the weight adjusted to 10.5 to 11 lb. per gal. The viscosity was adjusted as closely as possible to 35 seconds (Marsh funnel), and the water loss by filtration adjusted to 25 ml. per half hour on a 3-in. diameter plate at a pressure of 100 lb. per sq. in. Gunning the mud was avoided whenever possible, in order that too large a volume of sand would not be carried in the mud. The presence of large amounts of sand is liable to cause sanding up of the moving parts of the barrel and to prevent proper operation of the barrel.

It is believed that attention to the condition of the drilling mud is essential in order to obtain the best possible core samples. Experience indicates that, when the water loss from the drilling mud is high, the degree of pollution of the core by water from the drilling mud is more severe; and, in the case of friable sands, poor drilling muds cause breaking of the core, resulting in poor recovery and poor samples. A drilling mud with the following properties has been found to be satisfactory:

Weight—10.5 to 11 lb. per gallon (will vary some with depth and pressures expected).

Viscosity—35 to 38 seconds (1,500 ml. in; 1,000 ml. out).

Water loss—20 to 35 ml. per half hour on a 3-in. diameter plate at a pressure of 100 lb. per sq. in.

Sand content—Not more than 5 per cent by volume.

A drilling mud with these properties, in general, will not be difficult to obtain, and will be satisfactory for most coring operations. In some cases, however, it will be desirable to reduce the water loss to as low as 5 ml., particularly when cores of small diameter are being cut.

Core Analysis

The analytical procedure used to measure the quantities of interest in a pressure core analysis may be divided into two parts: (1) The operations performed on the derrick floor; and (2) the operations performed in the laboratory.

When the core barrel is laid down, it contains the core recovered. All excess volume is filled with drilling mud. The first measurement made is that of the pressure obtained. This pressure should be approximately equal to the hydrostatic head of mud at the coring depth. Its measurement tells whether the barrel has operated properly. Second, the amount of gas contained in the core is measured. This may be free gas, or gas in solution in the oil, or both. A separator and gas meter are connected to the bleedoff port of the pressure tube. The pressure then is relieved by rupturing a disk, and the gas and liquid are allowed to escape through a valve. The drilling mud and any oil produced are trapped in the separator, and the volume of gas evolved is measured by the meter. The meter used is a three-diaphragm positive-displacement type that can be read to one-thousandth of a cubic foot. The temperature of the gas is taken to be the same as the temperature of the mud in the separator. The pressure in the barrel is reduced at the rate of approximately 150 lb. per sq. in. per minute. After the pressure in the barrel has been reduced to atmospheric, all of the mud contained in the core barrel is collected, the core recovery is noted, and samples of the core are taken for analysis. A sample of the drilling mud used at the time of the coring also is taken for laboratory examination.

In the laboratory, the following quantities are measured: Porosity, permeability, residual oil saturation, residual water saturation, residual salt content of rock as sodium chloride, oil content of drilling mud from core barrel, salt content of drilling mud from core barrel, salt content of drilling mud from circulating system, and lump density of dry rock.

In some cases a water-soluble tracer was added to the drilling mud in order to demonstrate the presence of water from the drilling mud in the core and to estimate the amount of such water. Dextrose,* a sugar compound, was used for this purpose.

Cores were taken in the Louden and Elba fields in Illinois. Table 1 shows representative analysis

*Pyle and Jones, Drilling and Production Practice, 171-8 (1936).

for the cores taken at Louden, where most of the work on the pressure core barrel was done. Some work has been done in the Elba field, and these analyses are shown in Table 2. (The author presented analyses of six other pressure cores taken at Louden and two others taken at Elba which are not given here.) A pressure core barrel that cuts a 2⅜-in. core was used to take these cores. For the purposes of discussion, each quantity will be considered separately.

Porosity

The porosity is measured on samples of the core from which all fluids have been extracted. It is expressed as per cent of the total volume of rock, and is a measure of the capacity of the rock for holding fluids. A Washburn-Bunting porosimeter was used to make the measurement. This instrument measures effective porosity.

Permeability

The permeability was measured on the same sample as the porosity. The permeability of the sample to air was the quantity measured. The A.P.I. standard procedure* was used.

Residual Oil Saturation

The residual oil saturation was determined by distillation of the oil from a sample of the core. For cores from the sands at Louden, the residual oil saturation will average 22 per cent of the pore volume. For cores from the Palestine sand at Elba, the residual oil saturation will average 25 per cent of the pore volume, and in one case was observed to be as high as 38 per cent of the pore volume. This figure has been found to vary with the size of the core cut, and also with the degree of pollution of the core with water from the drilling mud. In general, the greater the water loss from the drilling mud, the larger the amount of oil that will be removed from the core during the drilling operation. The smaller size cores have been found to be affected most seriously by the drilling mud.

Residual Water Saturation

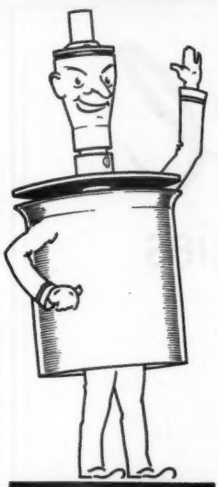
This quantity is measured by distillation of the water from a sample of the core. In Louden, cores of 2⅜-in. diameter will have residual water saturation averaging 48 per cent of the pore volume. In smaller cores (1⅝ in. in diameter) the residual water saturation will average 52 per cent of the pore volume. Here is seen the influence of the size on the degree of invasion of the core by the water from the drilling mud. Two important facts are noted: (1) It is brought out that the water obtained from the core by distillation is a mixture of water from the drilling mud and any formation water that may have been present. (2) The amount of pollution by water is

*A.P.I. Cole No. 27: "Standard Procedure for Determining Permeability of Porous Media (tentative)" (Oct. 1935).

TABLE 1—ANALYSES OF PRESSURE CORES

Well data—		
1. Pool	Louden	Louden
2. Well	W. Logue 4	W. Gregg 2
3. Formation	Weller	Weller
4. Depth (feet)	1,480.5 to 1,489	1,525 to 1,533.5
5. Elevation (feet)	581	573
Drilling data—		
6. Core cut (in.)	102	102
7. Core recovered (in.)	96	87
8. Core recovery (per cent)	94.1	85.3
9. Rotary-table speed (r.p.m.)	45	50
10. Drilling weight (lb.)	12,000	13,000
11. Pump pres. (lb./sq. in.)	170	220
12. Mud flow rate (gal. per minute)	224	247
13. Mud weight (lb./gal.)	10.1	10.5
14. Mud viscosity (sec.)	34	35
Measurements—		
15. Pressure in core barrel (lb./sq. in.)	580	690
16. Length of sand core recovered (in.)	96	77
17. Diameter of core (in.)	2.3	2.25
18. Average porosity (per cent total volume)	20.1	20.6
19. Average permeability (md.)	221	64
20. Average residual oil saturation of core (per cent of pore volume)	23.7	17
21. Average residual water saturation of core (per cent of pore volume)	46.2	58
22. Average residual salt content of core (per cent weight of dry rock)	0.19	0.235
23. Gas volume (cu. ft.)	0.432	0.154
24. Gas temperature (°F.)	80	70
25. Volume of mud in core barrel (cu. cm.)	4,000	3,900
26. Oil content of mud in core barrel (cu. cm.)	41	22.2
27. Sodium chloride in mud from core barrel (g. per l.)	3.4	5.4
28. Sodium chloride in mud from circulating system (g. per l.)	1.1	2.8
29. Lump density	2.18	2.20
Calculated data—		
30. Vol. of core (cu. cm.)	6,570	5,050
31. Gas volume at 60° F. (cu. ft.)	0.416	0.151
32. Total volume of oil in core and mud (bbl.)	0.00223	0.00126
33. Gas-oil ratio (cu. ft. per bbl.)	187	120
34. Residual connate water (per cent of pore vol.)	18.8	22.9
35. Prod. connate water (per cent of pore vol.)	6.35	9.1
36. Total connate water found (per cent of pore volume)	25.15	32.0
37. Estimated formation volume factor	1.09	1.09
38. Residual oil at reservoir conditions (per cent of pore vol.)	25.8	18.5
39. Prod. oil at reservoir conditions (per cent of pore volume)	3.4	2.33
40. Drilling water found in core (per cent of pore volume)	27.4	35
41. Total voids accounted for (per cent of pore volume)	81.75	87.83

Salt concentration of brine from Louden, 110,000 p.p.m.



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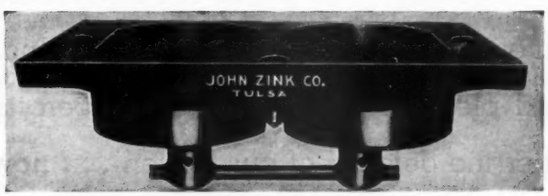

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greater in cores of smaller diameter. It can be seen that additional information is needed before any reliable estimate of the amount of water originally present in the formation can be made.

TABLE 2—ANALYSES OF PRESSURE CORES

Well data—		
1. Pool	Elba	Elba
2. Well	A.W.Kuder 2	A.W.Kuder 2
3. Formation	Palestine	Palestine
4. Depth (feet)	1,691 to 1,698	1,698 to 1,705
5. Elevation (feet)	363	363
Drilling data—		
6. Core cut (in.)	84	84
7. Core recovered (in.)	72	48
8. Core recovery (per cent)	86	57
9. Rotary-table speed (r.p.m.)	50	50
10. Drilling weight (lb.)	9,000	9,000
11. Pump pres. (lb./sq. in.)	170	170
12. Mud flow rate (gal. per min.)	236	236
13. Mud weight (lb./gal.)	9.5	9.5
14. Mud viscosity (sec.)	34	34
Measurements—		
15. Pressure in core barrel (lb./sq. in.)	650	620
16. Length of sand core recovered (in.)	72	48
17. Diameter of core (in.)	2.24	2.20
18. Average porosity (per cent of total volume)	18	18
19. Average permeability (md.)	340	340
20. Average residual oil saturation of core (per cent of pore volume)	23.2	23.2
21. Average residual water saturation of core (per cent pore volume)	21.4	21.4
22. Average residual salt content of core (per cent by weight of dry rock)	0.0516	0.0495
23. Gas volume (cu. ft.)	0.205	0.124
24. Gas temperature (°F.)	49	58
25. Volume of mud in core barrel (cu. cm.)	6,227	6,750
26. Oil content of mud in core barrel (cu. cm.)	73	66
27. Sodium chloride in mud from core barrel (g. per l.)	0.7109	0.6675
28. Sodium chloride in mud from circulating system (g. per l.)	0.4212	0.4212
29. Lump density	2.09	2.09
Calculated data—		
30. Volume of core (cu. cm.)	4,650	3,000
31. Gas volume at 60° F. (cu. ft.)	0.210	0.125
32. Total volume of oil in core and mud (bbl.)	0.00178	0.00110
33. Gas-oil ratio (cu. ft./bbl.)	118	113
34. Residual connate water (per cent of pore vol.)	10.20	9.70
35. Produced connate water (per cent of pore vol.)	3.80	5.6
36. Total connate water found (per cent of pore volume)	14.00	15.3
37. Estimated formation volume factor	1.07	1.07
38. Residual oil at reservoir conditions (per cent of pore volume)	24.80	24.80
39. Produced oil at reservoir conditions (per cent of pore volume)	9.33	13.10
40. Drilling water found in core (per cent of pore volume)	11.20	11.7
41. Total voids accounted for (per cent of pore vol.)	59.33	64.9

Salt concentration of brine from Elba, 59,000 p.p.m.

Salt Content of Core

The amount of salt contained in the core is determined by analysis. This quantity is expressed as sodium chloride. In the Louden area the salt water produced from wells in the Weiler or Bethel sands contain salt in the amount of 110,000 p.p.m. If, then, sufficient water is added to the salt found in the core to make a solution of this concentration, the percentage of the total volume occupied by this salt water can be established. In the case of a 2⅝-in. diameter core, this procedure shows that only about 25 per cent of the pore volume is occupied by this volume of salt water. In the case of a 1⅝-in. core, only 5 per cent is occupied, according to this analysis. Here is a striking example of effect of core size on the degree of pollution by water from the drilling fluid. Here, also, is seen the unreliability of salt content of the core as a measure of the original connate-water content. It is apparent, too, that the smaller the diameter of the core cut, the greater the need for mud treatment. When cores of small diameter are cut, the water loss from the

drilling mud should be reduced to as low a figure as possible.

Salt Content of Mud From Core Barrel

First, the mud in the circulating system is analyzed for its salt content. Then an analysis of the mud contained in the core barrel is made. It is found that it contains a much greater amount of salt than the mud in the system. Now there are only two ways for this increase in salt content to come about: one is by diffusion from the concentrated solution in the core to the more dilute solution surrounding it; and the other is for the salt water to be produced from the core under the influence of the expanding gas during the time that the pressure is reduced from static bottom-hole pressure to atmospheric pressure. In order to obtain some information on this point, a salt-water sand just above the producing horizon was cored.

This sand contained salt water of approximately the same concentration as that found in the producing sand. In this case it was found that there was no observable increase in the salt content of the drilling mud in the core barrel. Thus, it appears that there is only one way for this increase in salt content of the mud to occur, and that is for some of the original formation water to be produced from the core. According to the data of the analysis, amounts of water from 70 ml. to 120 ml. are so produced. This occurs on cores taken from wells that did not produce any water.

If the core obtained was a true equilibrium sample, in general there would be no production of water upon release of pressure; only oil would be produced. Hence, to account for this occurrence, it appears that the invasion of the core by water from the drilling fluid not alone altered the amounts of oil and water present, but changed their distribution among the pore spaces. Thus, it appears that the connate water is displaced from its original equilibrium position.

In the case of cores taken in the sands at Louden, if the amount of salt from the core found in the drilling mud from the core barrel is added to that found in the core and, if to this total salt is added enough water to make a solution of 110,000 p.p.m. concentration, it is found that, on the average, 33⅓ per cent of the pore volume is accounted for. This, then, is certainly a more complete accounting for the salt-water content of a core than was possible before and, as such represents a far more reliable estimate of connate water than was available in the past.

In the case of cores taken in the Elba pool, an average connate-water content of 15 per cent was obtained by this analysis. The salt content of the core alone showed only 11 per cent connate water. Here, again, the accuracy of the connate-water estimate is shown to be improved. Obviously, this is of the utmost importance in the estimation of reserves. Further, some information has been gained as to the mechanism by which the core arrives in its final state at atmospheric pressure, and this is important in order to be able to make the most reliable interpretation of the data of core analyses.

It appears from these data that, in the process of coring, it is largely oil that is removed from the core by the flushing action of water from the drilling mud, and that the connate water remains largely unchanged in amount. This, however, is only true in the case of large-diameter cores (i.e., 2⅝-in. or larger). In the case of small cores, a substantial amount of the salt content of the core is removed during this flushing period. Thus, when the pressure on the core is reduced, both water and oil are produced, and the water produced is a mixture of water from the drilling mud and the original connate water. From this picture, the flushing action of the drilling mud seems to manifest itself as a form of water drive ahead of the bit. As a point of interest, the graph shown in Fig. 1 gives the relation between water content and permeability observed on 2⅝-in. diameter cores taken in Illinois with the pressure core barrel.

Core Pollution

The amount of water in the core from the mud was estimated by adding a water-soluble tracer compound to the drilling mud. The core then could be analyzed for the tracer compound, and thus the amount of water carried with it could be determined. It is observed that the water from the drilling mud had permeated the entire core. However, the amount of pollution was about twice as great around the outside edge of the core. In fact, a ring approximately ½ in. deep was defined. This observation gives an indication of another type of pollution, viz., a radial pollution. This radial pollution is most serious in the case of cores of small diameter, and becomes less serious as the diameter of the core is increased. The effects of radial pollution are much less pronounced

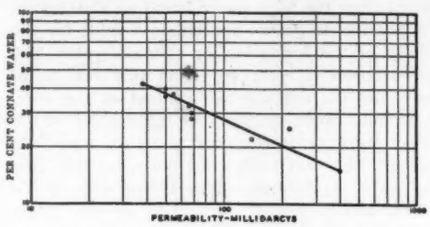

Fig. 1—Connate water vs. permeability

in a core that contains a heavy, more viscous oil.

The amount of water from the drilling mud found in cores of 2⅝ in. in diameter averages 23 per cent. This is for a core with 18 per cent

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Oil Content of Mud From Core Barrel

When the pressure in the core barrel is reduced to atmospheric, oil is produced from the core under the influence of the expanding gas. This oil can be recovered from the mud in the core barrel by distillation. From the amount of oil so produced, some idea of the production abilities of the well can be obtained. Although the data obtained have not been sufficient to permit complete discussion of this feature, a few important observations have been made.

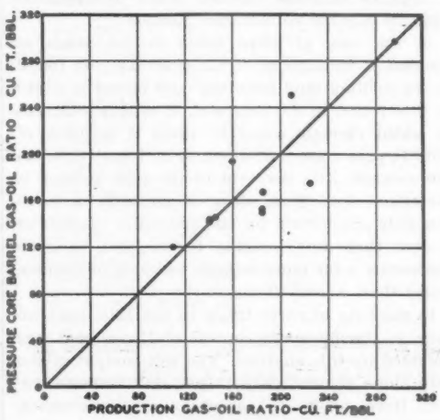
The most important of these is that, in a given horizon, there is a correlation between the amount of oil produced in the core barrel and the initial potential of the well. For example, a core (8 ft. long by 2⅝ in. in diameter) taken from a 140-bbl.-per-day well produced 20 ml. of oil; a core from a 170-bbl.-per-day well produced 25 ml. of oil; and a core from a 360-bbl.-per-day well produced 40 ml. of oil. A definite trend in the data is certainly apparent. From such data as these, then, it may be possible to build up a sort of production index for a pressure core that would give an approximate measure of the ability of a well to produce oil.

Gas-Oil Ratio

Gas-oil-ratio data have been taken with the pressure core barrel. Cores taken when the north end of the Louden pool first was being drilled gave an average gas-oil ratio of 159 cu. ft. per bbl. This figure was in approximate agreement with both the production gas-oil ratio and with the gas-oil ratio as obtained from bottom-hole samples. Bottom-hole samples taken at that time gave, on differential liberation, a gas-oil ratio of 140 cu. ft. per bbl. and, on flash liberation, a gas-oil ratio of 170 cu. ft. per bbl. Inasmuch as the liberation from the core is neither a purely differential nor purely equilibrium type, but some composite of the two, it is to be expected that the value obtained with the core barrel would be somewhere between the two. Cores taken in the same area a year later showed an increase in gas-oil ratio. The gas-oil ratio in the pool showed a comparable increase. Apparently, as the pressure in the reservoir declined, gas was released from solution to fill the voids made by the withdrawal of oil, and the gas-oil ratio showed an increase. The core barrel has followed this trend. Further, when the gas-oil ratios obtained with the core barrel are compared with the production gas-oil ratio on the same wells, a definite correlation is observed. As might be expected, the gas-oil ratio is no longer in agreement with the solution gas-oil ratio as obtained from bottom-hole samples.

Cores taken in the Smackover lime at Magnolia, Ark., gave a gas-oil ratio of 820 cu. ft. per bbl. This figure is in good agreement with the value of 900 cu. ft. per bbl. obtained from bottom-hole samples.

The correlation between gas-oil ratios as determined with the pressure core barrel and production gas-oil ratios measured on the same wells is shown in Figs. 2 and 3. In Fig. 2 is shown the



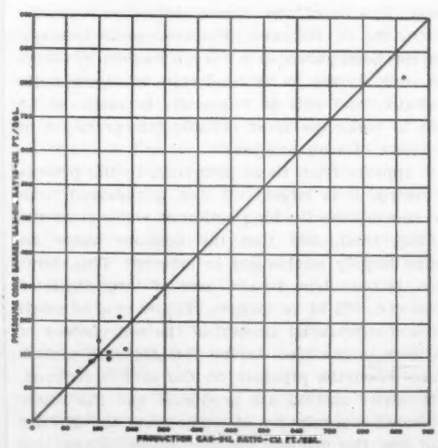


Fig. 2 (top)—Correlation of wells in the Louden pool. Fig. 3 (bottom)—Data from cores at Magnolia, Ark.

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correlation for wells in the Louden pool. Fig. 3 includes the data from Magnolia, Ark.

Cores have been taken also in gas-cap areas, and these cores have recovered the gas contained and have defined the gas-oil contact. In locations where there is some segregation of gas and oil, the core barrel has shown the change or decrease of gas-oil ratio with depth in the formation. This information can be of use in the proper locating of the casing seat. In Fig. 4 is shown an example of this work. The core taken in the upper part of the sand showed a residual oil saturation of about 7 per cent of the pore volume, and 0.201 cu. ft. of gas was liberated from the core. In the lower part of the sand the oil saturation increased to about 20 per cent of the pore volume, and the volume of gas liberated dropped to 0.075 cu. ft. Thus, it is seen that the gas-meter reading alone was a valuable indication of subsurface conditions in this horizon; and, coupled with a complete analysis, a far more certain determination of the properties of the formation is possible with a pressure core

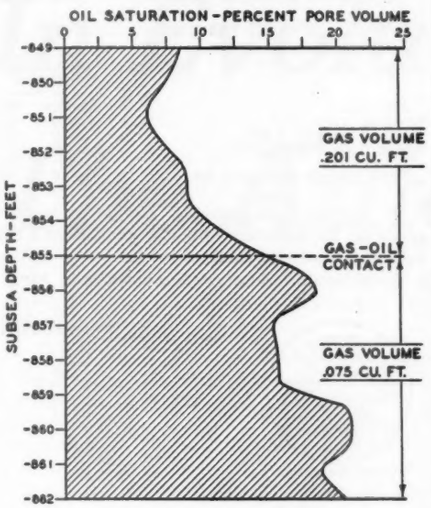


Fig. 4—Gas-cap core comparison

Discussion

The results obtained with the pressure core barrel now can be summarized. It is seen that reliable gas-oil-ratio data have been obtained. These data can be considered as an index of the energy available in the oil for production. Thus, it is known immediately whether a formation cored with the pressure core barrel is "alive," or whether it merely contains dead oil or oil under very low pressure. It has been found that gas reservoirs can be cored successfully. This fact is of the utmost importance when it is desired to obtain core data in a distillate reservoir. The residual oil saturation in cores taken from distillate wells will average about 2 per cent of the pore volume. Thus, with a conventional core barrel, the major portion of the hydrocarbon content of the core is irretrievably lost.

Another advantage of pressure core data that is observed is found in coring certain lime formations. In many cases, the properties of the formation are so lacking in uniformity that it is very difficult to make a detailed sample analysis. With the pressure core barrel it is possible to obtain an overall index of the properties of a well through the medium of the gas data and volume of oil produced from the core when the pressure in the barrel is relieved. The detailed sample analysis then can be used as auxiliary data to aid in making a good estimate of the properties of the formation.

An individual account has been given for each quantity of interest in a pressure core analysis. It is shown that more detailed information is now available on each quantity of the analysis and, further, that some knowledge of the process by which a core arrives in its final state has been obtained. This new information is indicated in the following summary:

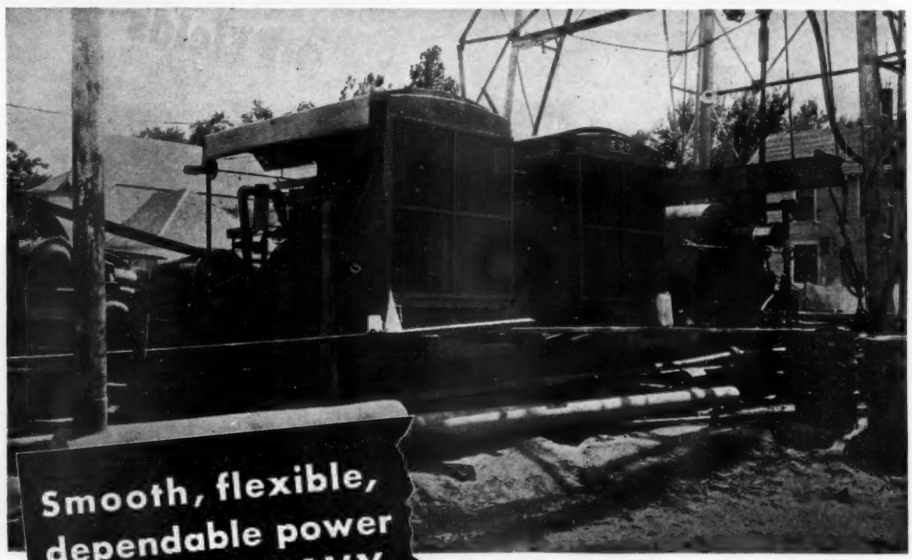
(*a*) The observations made on tracer experiments and on the salt content of the drilling mud in the core barrel have disclosed two possible mechanisms by which the core is changed from its original state. These have been described as: (1) a water drive ahead of the drilling bit, which produces oil from the core and displaces the connate water from its equilibrium position; and (2) a radial invasion which leaves the outer part of the core extensively polluted with water from the drilling mud.

(*b*) The analysis of the drilling mud in the core barrel has given a more complete account of the salt content of the core than was heretofore available. Thus, a more reliable estimate of connate water now can be made. This is of importance in the estimation of reserves. Further, some light has been thrown on the nature of connate water. Evidence is given here that the connate water is not a water entirely bound to the shales and other minerals of the rock, but it is, in part at least, a liquid capable of motion.

(*c*) The oil produced from the core when the pressure in the barrel was relieved has been measured. In a given horizon, a correlation between the oil produced and the potential of the well was observed.

(*d*) Reliable gas-oil-ratio data have been obtained. This feature has been discussed in some detail.

(e) It is now possible to give a more complete account of the materials that filled the pore spaces of the core at the time the core was taken. This



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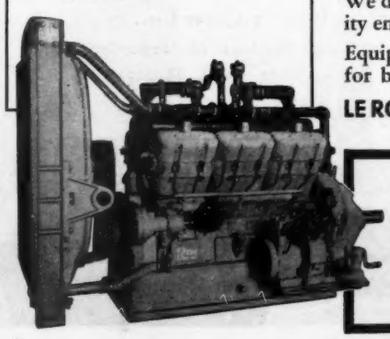

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account is given in Table 3 for 2⅜-in. cores from the Louden pool and the Elba pool.

TABLE 3

Material—	Per cent of pore volume occupied: Louden	Elba
Residual oil (corrected for shrinkage)	24.0	25.0
Produced oil (corrected for shrinkage)	3.0	14.0
Connate water: Remaining in core	25.0	11.0
Produced in core bbl.	8.5	4.0
Water from drilling mud	22.0	14.0
Total volume accounted for	82.5	68.0

TABLE 4

Material—	Per cent of pore volume occupied: Louden	Elba
Residual oil	22.0	23.4
Residual connate water	25.0	11.0
Water from drilling mud	22.0	14.0
Total volume accounted for	69.0	48.4

By way of comparison, a similar account is given for the materials found by analysis of a conventional core, in Table 4.

These results are shown graphically in Figs. 5 and 6. Thus, it is seen that a more complete and more detailed account of the fluid contents of a core is given by the pressure core barrel. That part of the pore volume unaccounted for by the analysis is due to a portion of that water from the drilling mud that was in the outer part of the core being forced out of the core under the influence of the expanding gas in the inner portion of the core. As this water has approximately the same concentration of dissolved solids as the drilling mud in the core barrel, it was not possible to detect its presence by analysis.

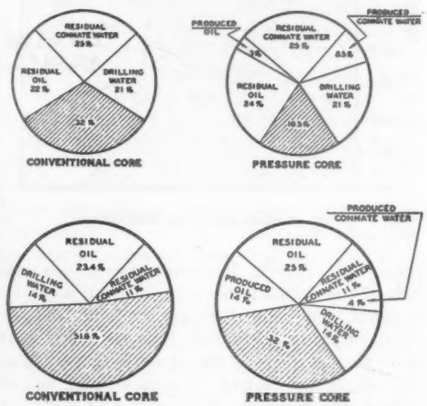


Fig. 5 (above)—Louden field—volumetric material balance. Fig. 6 (below)—Omaha field—volumetric material balance

It is believed that the pressure core barrel has shown many advantages over conventional coring tools, and has yielded interesting and important information. It should prove to be an important addition to the equipment of the petroleum industry.

●

California Source Handbook

A 300-page reference volume, "Handbook of Sources of Economic Data Pertaining to California," has been published by the California State Chamber of Commerce, 350 Bush Street, San Francisco, Calif. The book lists some 296 public and private agencies in the United States which are sources of statistical or factual information about all phases of economic life in California. Described in it are the fact-finding activities of each source and the statistical data available. A 60-page alphabetical subject index referring the searcher by code numbers to the principal source agencies described in detail in the other sections of the book is also included. Mail copies are available at a price of $1.25.

Petroleum's Part In Evolution of The Automobile

By T. A. BOYD
Research Laboratories Division, General Motors Corp.

THE horse was so slow and unsatisfactory that the wish for a carriage to go without horses was a very, very old one. And down through the years, men tried many ways to make that ancient wish come true. They built muscle-power carriages, wind-power carriages, spring-power carriages, steam-power carriages, and at long last the gasoline-power carriage itself. During all that lengthy period, progress was, to be sure, at a snail's pace. But there was progress nevertheless. It consisted in the invention, one by one with long intervals between, of the elemental units of which the automobile was finally made.

Thus, for instance, a change-speed gear, such as is now used in the transmission of automobiles, was described in 1802 by the Englishman, Richard Trevithick. The differential gear, too, which allows one of the driving wheels to turn faster than the other as is necessary in rounding turns, was patented by Onesime Pecquer in 1828. The stub-axle scheme of steering by swiveling each front wheel on its own pivot was invented in 1828 also.

It was in 1824 that the theory of the action of heat engines was fully expounded by Sadi Carnot. He suggested that the best way to get power and efficiency is by burning the fuel not in a furnace outside, as in the case of the steam engine, but directly within the engine itself, and further that the charge of air and fuel should be highly compressed before firing. Carnot even suggested using the exhaust of the internal-combustion engine to heat the boiler of an auxiliary steam engine.

Mr. Boyd, who is widely known in the oil industry, has been head of the motor fuel department of General Motors research laboratories division since 1923. He was coodiscoverer, along with Charles F. Kettering and Thomas Midgley, Jr., of the antiknock effects of the liquid compounds of lead. He is the author of numerous technical papers and two books. The accompanying article is a specially prepared abridgment of a talk given by Mr. Boyd at a dinner meeting of the Institute of Petroleum, in Chicago, November 1940, in which he traces the development of the automobile and brings out the important part played by petroleum in its evolution.

Then, after no little intervening history, the Frenchman, Lenoir, began in the 1860's to build internal-combustion engines commercially. He was able to sell three or four hundred of them. Lenoir's double-acting gas engines had electric ignition with spark plugs, and even a distributor. In the early 1860's also Beau de Rochas, French railroad engineer, described and patented the four-stroke cycle, in which one of the strokes compressed the charge of air and fuel.

It was thus during this long evolution that one by one—and before the birth of the automobile itself—the following elements essential to the automobile were invented or used:

Gasoline engine, with
- Cylinder and piston.
- Crankshaft and connecting rod.
- Valves, carburetor.
- Electric ignition, spark plug, carburetor.
- Four-stroke cycle, and compression for power.

Wheel, and pneumatic tire.
Steering wheel, and stub-axle steering.
Gear, and change-speed gear.
Differential.
Leaf spring and coil spring.

This list, as may be seen, includes all the elements necessary to make an automobile.

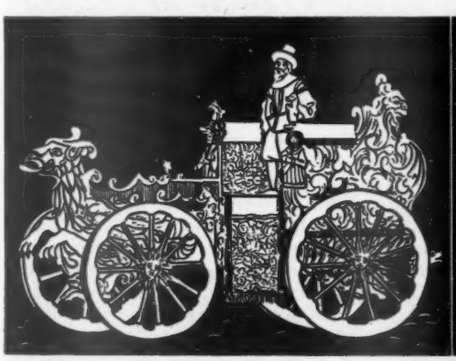
The Automobile Had to Wait on Gasoline

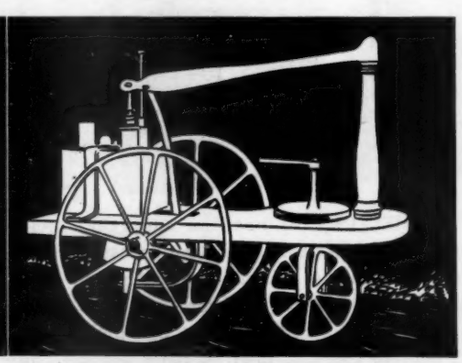
Why, then, if all these needed elements were available, was not the automobile born sooner? The principal answer is that, in spite of the apparent completeness of the list shown, something very vital is missing—gasoline and oil.

Gasoline was the keystone which finally made it possible to do what no one had been able to do in a permanent way before, although many had tried. This was to assemble all those embryonic elements into a carriage that would really go without horses. It was only a few years after gasoline became available, and right after a successful engine to run on gasoline had been developed, that active efforts were begun to utilize the gasoline engine as power for a self-moving road carriage. And, from the efforts of such pioneers as Benz and Daimler in Germany and Levassor in France, the gasoline automobile did become an actuality in the 1880's.

This was petroleum's first part in the evolution of the automobile. It is why Allan Nevins seems well justified in saying in his new work, "John D. Rockefeller," that Col. Edwin L. Drake will be as immortal a discoverer as his great English namesake, Sir Francis Drake.

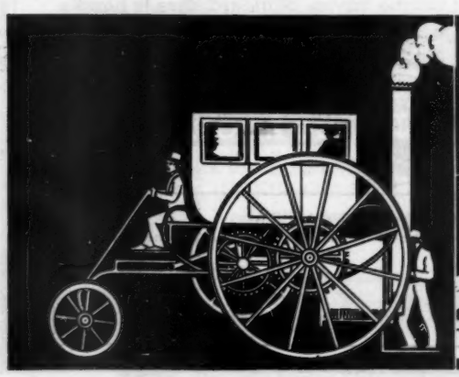
All this does not detract in any wise from the

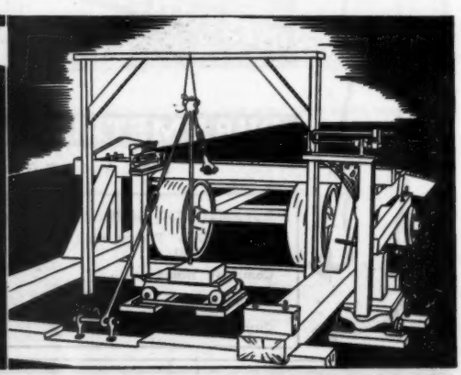




Below: (left) In addition to the application of the spur gear to the propulsion of a road carriage, as shown in this 1802 model, the Englishman, Richard Trevithick, anticipated the automobile transmission. This he did by conceiving and patenting 140 years ago a change-speed gear. (Right) As a preliminary to the Times-Herald race for horseless carriages, held in Chicago on Thanksgiving Day, 1895, each vehicle had to pass a test made on this apparatus, which was perhaps the first chassis dynamometer

Above: (left) Three hundred years ago the self-moving carriage shown here was thought to be so successful that one was sold to the crown prince of Sweden and another to the king of Denmark. Only by the efforts of strong men hidden inside could these "muscle-power" carriages move. (Right) This first steam-power car was only a model, but an operating one, and it is said to be the first self-moving vehicle to employ that vital mechanical linkage—the crank and the connecting rod.





great accomplishment of the automobile pioneers. They surely had plenty of engineering to do in putting those embryonic elements together into a car that would work. They had to get the needed elements first. And although, as just shown, most of them had been invented or used before, it was not possible to buy many of them over the counter. A few even had to be invented all over again, the original invention having been forgotten. Some of these elements were not even used in those first cars. For instance, a few avoided the need for a differential by driving on one rear wheel only. But primarily the problem of those who pioneered the horseless carriage was the engineering one of deciding just what elements to use, of finding how to make them so they would work, and then of learning how to put them together into an assembly that would run. Thus the contribution of the automobile pioneers was primarily in engineering, not in invention.

The foregoing puts no discount either upon the greatness of the engineering endeavors which have converted the horseless carriage from the crude and troublesome contraption of the 1890's into the beautiful, dependable, and comfortable car of today. It took the early automobile builders several years to get well started on that upward evolution, and so to live down the jest of the time about the car with the wooden wheels, wooden axles, wooden body, wouldn' run. So often those early cars would not run that their most useful accessory was a tow rope. When in 1899 the U. S. Army bought three automobiles for the use of officers, it was stipulated that suitable provision be made for hitching mules to them for towing purposes.

Where Automobile Advance Began

The Duryea "motor wagon" which won the Times-Herald race in Chicago on Thanksgiving Day, 1895, had a two-cylinder engine that developed less than 2 hp. and used over 3 lb. of gasoline per horsepower-hour in doing it. This is known so precisely because, as a preliminary to that race, each vehicle had to pass a test conducted by an official committee. These tests were in no wise perfunctory, but were carefully and conscientiously made on what was probably the first chassis dynamometer. This device had rolls for the driving wheels, a prony brake and platform scales for measuring power, and an arrangement of truss and scales for measuring drawbar pull.

The results of those tests were published in detail at the time (Horseless Age, Feb. 1896, p. 11), and are extremely interesting as giving engine characteristics at the outset of the industry in the United States. The engines in the cars tested prior to the race had outputs varying from 1 to 5 hp. Scarcely any of the cars went through the elementary tests without serious troubles, such as broken sprocket chains, slipping belts, and broken bearings. Gasoline consumption in pounds per horsepower hour at the rim of the driving wheel varied from 6 lb. for the average to over 20 lb. for the worst. Incidentally, "gasolene" was spelled with an "e" in those days, and it sold for about 12 cents a gallon.

Course of Automobile Progress

It was from there that the automobile began its marvelous evolution upward. In recent years, this progression has consisted of five main trends, as follows: (1) The trend toward greater comfort and better appearance. (2) The trend toward lower cost, both in purchase price and in operating expense. (3) The trend toward higher power and better performance. (4) The trend toward more ton-miles per gallon. (5) The trend toward greater safety.

These trends have matched, and also been greatly aided by, the simultaneous evolution in gasoline. This is especially so in respect to octane number and volatility. Thanks to cracking, polymerization, and other advances in refining methods, and to the extensive use of tetraethyl lead, big improvements in both of these qualities have been made, particularly during the two decades just past.

In respect to the reduction in cost spoken of, the customer today has to pay only a third as much for a car of given size and weight as he did in 1920. And, furthermore, it costs him only half as much to run his car now as it did 15 years ago. The decreasing cost of gasoline is, of course, one important factor in the downward trend in cost of operation. During the 15-year period named, the reduction in the retail price of gasoline, exclusive of taxes, has been about 8 cents per gallon.

In further respect to the reduction in the cost of cars, spoken of before, it has frequently been said that machines and improved methods of manufacture have been throwing men out of work in the automobile industry. But the truth is that more men, not fewer, are employed per car now than used to be the case. The reason is that the increasing size and complexity of cars has more than offset the effects of machines and improved manufacturing methods upon man-hours per car manufactured. Also, hourly wages of the men who make cars are higher now than at any time in the past. Their wages are 50 per cent higher than in 1923, for instance.

In the trend toward higher power and better performance, the output of an engine of given size or cubic displacement has, during the past 15 years, been almost doubled. And this gain, as before said, is due in considerable degree to more volatile and more nearly knock-free gasolines, for these have allowed automobile engines to be built with higher compression ratios and better breathing capacities.

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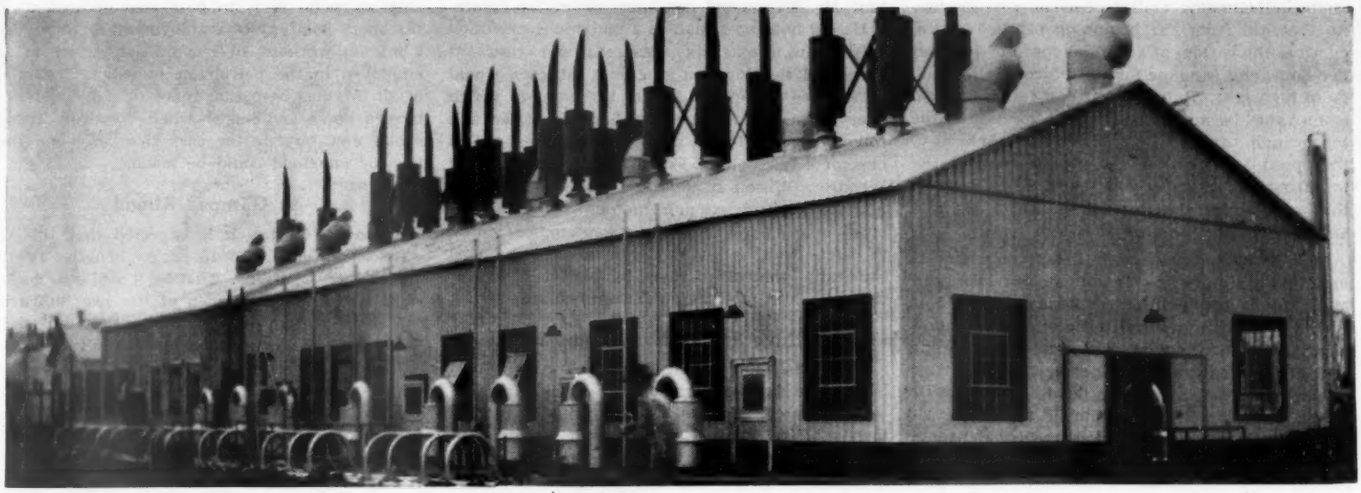

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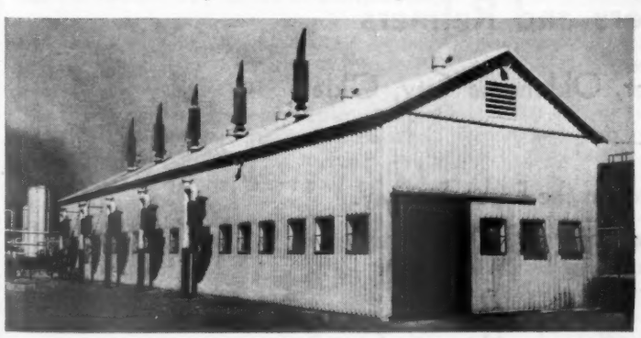
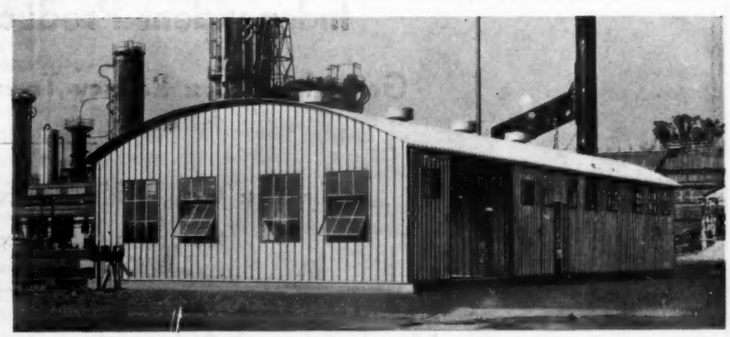

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of the hill-climbing ability of a car was to start up that hill from the beginning of the vertical curve at the bottom at an initial speed of 10 miles per hour, and see how far up the course it could go in high gear. But long ago that test lost much of its value, because all cars could go clear to the top in high. And so the criterion was changed to the speed at which the car would go over the top from a 10-mile-per-hour start. Nowadays, in that test, cars accelerate up the hill at a fast rate and go right over the top at a high speed.

Both in appearance and in details of engineering, the evolution of the automobile has been made to follow public acceptance. And, if it should seem that in some respects this evolution might better have followed a somewhat different course, such as to emphasize economy more than performance, the explanation lies in demonstrated public preference. The automobile maker has always kept his eyes open to see just what people want most. It is not his to dictate customer demands but to fill them. Nevertheless, while giving car users the improved performance demanded, the industry has found means of improving ton-miles per gallon also. The increase in this latter respect has been more than 20 per cent during the past decade.

Woodrow Wilson Views With Alarm

In 1906, when Woodrow Wilson was president of Princeton University, he said this: "Nothing has spread socialistic feeling in this country more than the use of the automobile." The reason was, he said, that "to the countryman they are a picture of arrogance and wealth with all its independence and carelessness."

It is true that, 35 years ago when Woodrow Wilson said this, the automobile was little more than a rich man's toy. For at that time there were only a hundred thousand cars in the whole country, and surfaced roads were almost nonexistent. But there were some things that at that time Mr. Wilson did not know about the future.

He did not know that, in a marvelous evolution arising from extensive research and resultant industrial development, the cost of cars would be reduced by several fold to the point at which every Tom, Dick, and Harry has one. Even if a fellow cannot afford a new car, he can get a used one for a few dollars. For every car in use when Woodrow Wilson spoke there are 300 in service now. There are enough motor cars today for every one in the country to go automobile riding at once—and on Sunday afternoons it seems sometimes that all of them have. Nearly 85 per cent of white families on farms own cars today.

Events Have Proved Early Fears Needless

What has happened in the 35 years since 1906 is thus the direct inverse of that which Woodrow Wilson feared. He said what he did in the belief—a belief which was well nigh universal at the time—that the market for automobiles would always be limited to just a few wealthy people. How wrong that opinion was it is easy to see now. But, as often as not, the experience of the man who tries to foresee future events is like that.

It is chiefly because of consistent advances made within the petroleum industry and the automobile industry that history in this regard has been so different from what Woodrow Wilson feared. It is because the oil industry, by searching for better methods of finding oil, of getting it out of the ground more completely, and of making more and more gasoline per barrel of crude, has found means of furnishing gasoline and oil in huge amounts at prices continually lower and lower, and at the same time of improving its products. It is because, during the same period, the automobile industry has staged a steady advance toward cars which cost less and less to buy and to run, which are more dependable, more comfortable, and easier to drive, and which satisfy people's natural pride of ownership as well. It is in part also because motor transport itself gives employment to more than 6 million workers, over a million of whom are employed in the petroleum industry. The effect of all this has been that many who did not even have a horse and buggy when Woodrow Wilson spoke now own better cars than any one then had, or imagined could be made.

A Glimpse Ahead

As to the future, it is expected that this upward evolution—with its large benefits to the citizen—will continue. That is, it will still go forward if the technical men of the two industries can go on, as they have in the past, finding practical solutions for the problems involved.

Just what these problems are likely to be it is not the purpose of this paper to predict. But already apparent is the growing necessity for fitting fuels and oils to cars, and the cars to the fuels and oils, with more preciseness. And it surely looks as though this mutual dependence is likely to become more rather than less. There is, for instance, plenty of evidence to indicate that with rising octane numbers the matter of sensitivity to engine-operating conditions, or of variations in degree of freedom from knock as running conditions change, will still be with us and to an even more pronounced degree, much as that is to be regretted. Other problems too, such as oxidation and engine deposits in lubricating oils, together with altogether new problems that we do not yet know about, are likely to be with us in the future also. And, just as in past years, our best assurance of solving these problems as they arise is to go after them individually, mutually, and cooperatively, and to do so in a thoroughly aggressive manner.

Acknowledgment

Grateful acknowledgment is made of the help of E. W. Scanes in preparing illustrations for this paper.

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Digests of A. P. I. Papers

Presented before the midyear meeting, Tulsa, May 19-22, 1941

Evaluation of Diesel Fuels In Full-Scale Engines

W. G. AINSLEY (Sinclair Refining Co., East Chicago, Ind.) Report of Cooperative Fuel Research Committee.

THE octane value of a diesel fuel is the most practical single index of the oil's general usefulness. This is the conclusion drawn from the series of tests conducted on 15 full-scale engines by 10 laboratories as part of the C. F. R. fuel-research program. In this work four basis reference fuels and one blend of these were investigated.

The individuals and companies participating in the program as well as interpreting the results include W. G. Ainsley, Sinclair Refining Co.; W. F. Aug, Mack Manufacturing Co.; A. J. Blackwood, Standard Oil Development Co.; K. M. Brown, Caterpillar Tractor Co.; W. H. Browne, Caterpillar Tractor Co.; J. M. Campbell, General Motors Corp.; C. E. Cummings, Texas Co.; W. E. Drinkard, Crysler Corp.; J. O. Eisinger, Standard Oil Co. (Indiana); A. H. Fox, Standard Oil Co. (Indiana); H. M. Gadebusch, General Motors Diesel Division; L. W. Griffith, Shell Oil Co., Inc.; L. E. Hebl, Shell Oil Co., Inc.; S. L. Henrt, Fairbanks, Morse & Co.; C. G. A. Rosen, Caterpillar Tractor Co.; G. C. Wilson, University of Wisconsin; H. D. Young, Sinclair Refining Co.; G. W. Zabel, Fairbanks, Morse & Co.; University of Wisconsin; Shell Oil Co., Inc.; Fairbanks, Morse & Co.; Texas Co.; Atlantic Refining Co.; Standard Oil Development Co.; Chrysler Corp.; Caterpillar Tractor Co.; Mack Manufacturing Co.

The work represents a continuation of work first started in 1937 when the automotive diesel-fuels division of the C.F.R. was organized. Previous progress reports have been issued and these, together with the more recent research work, are summarized here. The conclusions of the report follows:

1. The ignition quality of the fuel (cetane number, A.S.T.M.) affects starting, engine smoothness, exhaust smoke, exhaust odor, and combustion-chamber deposits.

2. The volatility of the fuel (A.S.T.M. distillation) affects smoke and engine deposits.

3. The viscosity (Saybolt Universial seconds) affects smoothness and smoke. The importance of viscosity was recognized in the basic research program as involving the consideration of ease of circulation, atomization, penetration, injection pump-plunger leakage, lubrication quality, heat content, volatility, and overall power output The data on power output show a decrease in power with a decrease in viscosity, which may be caused in part by the effect of viscosity.

4. The gravity (A.P.I.) affects smoke, power, and fuel consumption.

5. The carbon residue on 10 per cent bottoms (A.S.T.M.) affects smoke and combustion-chamber deposits.

●

Corrosion of Copper-Alloy Condenser Tubes by Water

JAMES T. KEMP (American Brass Co., Waterbury, Conn.)

COPPER-BASE metals are especially well suited for use as refinery exchanger tubes cooled by water because of their ability to resist corrosion on both sides of the metal wall. Although reported tube failures reveal more frequent troubles on the stream side, water conditions among many refineries are unfavorable to the water side when compared with industries generally.

There seems to be much in refinery layout and equipment design that favors corrosion of condenser tubes. Three things may be mentioned herein: (1) the common practice of raising the cooling-water temperature almost to the boiling point by cascading shell-and-tube condensers, or by slow flow through the boxes of submerged condensers; (2) the very low water velocities within condenser tubes; and (3) the close packing of tubes in bundles. Each of these matters appears to have played a definite part in assisting the early destruction of tubes in cases brought to our attention. Each of these customs of the refinery can be supported by citing original cost, pumping cost, or need for close temperature control in some heat extraction operation. The trend in steam-condenser design is toward open-tube arrangements, simple circulating paths and velocities three to four times those common in refineries. Tubes last much longer in steam condensers, even those handling the same cooling-water supply as is used for refinery process cooling.

Condenser tubes are commercially available in ten or a dozen alloys. Many of these alloys, however, are not well suited to the vapor side but those that are so suited are sufficient in number to offer refiners some choice of corrosion-resisting properties on the water side. Prominent among the alloys used in oil refineries are: Admiralty metal, red brass, cupro nickel, and aluminum brass. Practically 80 per cent of the nonferrous condenser tubes used in American petroleum refining are of admiralty metal.

The most easily recognized characteristics of corroded condenser tubes offer a simple means of classifying water-side attack:

1. Thinning of the tube wall, metal remaining but lightly covered with deposits; (*a*) Uniform and widespread. (*b*) Localized pitting.

2. Attack marked by characteristic residual-corrosion products; (*a*) Dezincification, redeposited copper. (*b*) Chemical attack, metallic compounds.

3. Subsurface penetration; (*a*) Selective corrosion as in Muntz metal. (*b*) Grain-boundary attack.

4. Corrosion cracking.

5. Erosion.

The popular explanation of "dezincification" is that the alloy is dissolved slowly—both copper and zinc being taken up—but that the solvent water is not as capable of holding the copper in solution as it is the zinc. The zinc escapes in solution in soluble compounds, or may accumulate in masses of insoluble carbonates; but the copper is "redeposited" in metallic form. The redeposited copper is somewhat porous, and does not protect the underlying metal—but, instead, by virtue of its porosity, encourages further action.

This brief statement omits all reference to chemical action or to the minute electrical actions that may be a part of the mechanism. Dezincification occurs in all waters; and is hastened by mild corroding agents, by dissolved oxygen, by elevated temperatures. Brasses richer in copper than 80 per cent are seldom "dezincified." Cases of redeposition of copper on alloys higher than 85 per cent and on alloys with little or no zinc, but with nickel or silicon, have been observed occasionally.

A great deal has been said in the past few years about the prevention of dezincification by manipulation of the alloy. A great deal of importance has been accomplished in this direction by systematic researches conducted by brass-mill metallurgists. The first "inhibitor" intentionally used by brass makers was tin. At some time in the early 1880's it was observed in England that the addition of about 1 per cent of tin to 60-40 and 70-30 brasses improved their resistance to seawater corrosion without interfering with their valuable physical properties. The former came to be known in its two varieties as naval brass and Tobin bronze—the latter "admiralty metal" in deference to the preference given to condenser tubes made of it by the constructors of the Royal Navy.

Recently active attention has turned toward the beneficial influence of certain minor elements, viz., arsenic, antimony, and phosphorus, added to admiralty metal in definite though small amounts. Very definite retardation of dezincification under average condenser operating conditions has resulted from the use of these additions or "inhibitors."

●

Fatigue Effects in Roller Chain

A. E. FOCKE and W. A. WARRICK (Diamond Chain & Manufacturing Co., Indianapolis, Ind.)

THIS paper is a progress report on investigations of fatigue effects in roller chains, presented as such because the end of this research program is several years in the future. The methods employed to determine the endurance limits of roller chains are discussed, testing equipment is described and results of investigations of the endurance limits of several sizes of roller chains are given.

This research program had its inception in 1930, when fracture of crankshaft drive chains was encountered after too brief usage on a very few rig fronts, out of several hundred in the field, in pumping service. These peculiar instances of rig-front chain fracture were not the result of wear, nor was there evidence of defective material or manufacture. The rig fronts were equipped with

transmission roller chains conforming to Standard B 29a of the American Standards Association, to which type of chain the scope of this research program has been restricted. Although 40 years of experience had included no prior instances of roller-chain breakage attributable to fatigue effect, the evidence proved that the occasional breaks of rig-front chains had resulted from fatigue phenomena.

Based on experience gained in preliminary tests, a special fatigue machine, operating directly on actual chains and capable of applying the necessary millions of cycles of loading within a reasonable length of time, was designed and built. On a typical pumping unit almost 6 months is required to subject the link to 1,000,000 cycles of peak-load stress. On the small fatigue machine described in the article, 1,000,000 cycles can be produced in less than 17 hours and on another unit capable of testing 200,000-lb. chain, in 83 hours.

Most of the laboratory investigations thus far have been devoted to American Standard chains of the "heavy" series on account of their truer dimensional proportionality over that of chains of the "extra heavy" series—which are identical to the "heavy" series except that their link plates are thicker and of greater cross-sectional area. Preliminary tests to explore the effects of increased link-plate thickness confirm field experience that the surplus link-plate capabilities of "extra heavy" chains result in higher indurance limits than those of "heavy" chains of similar dimensions as to pitch, roller diameter, pin diameter, etc.

Inasmuch as maximum utility of fatigue information on roller chain as developed in laboratory and field work must be conditioned upon knowledge of the actual loads imposed on the chains of pumping units in representative service in the field, and because this knowledge is vital also to proper coordination of the field and laboratory branches of this research, a third branch of investigation was undertaken. This was the determining of actual service loads. Actual peak loads on pumping chains have been measured by means of special links, assembled into the chain. This "bracketing" method is slow and inconvenient so that a method was developed for measuring actual chain stresses with the De Forest scratch-recording gage, attached directly to the chain.

This gage gives a continuous record of stresses in the chain through approximately 50 stress cycles. The chains used for such tests were calibrated carefully in the laboratory on tensile and fatigue machines both before and after tests on the wells. A technique was developed, for matching the time of the incidence of the stress with the position of the crank arm and beam, by means of motion pictures and synchronized photographs. Sucker-rod indicator diagrams also were made at the same time to correlate chain loads with sucker-rod loads.

It was found that, on units on which chain fatigue had not occurred, the maximum load was predominantly within the "permissible" zone, below the load-cycle curve of the chain; whereas, on those severe wells that had broken chains, the maximum loads exceeded the fatigue strength. It is found also that on such wells there is always a high load that is repeated frequently enough to account for failure in the observed time required for failure, and consistent with the number of cycles to produce failure in the laboratory. This study was not yet complete enough to warrant inclusion in the paper an extended discussion of the data obtained.

Although tests covered a wide range of link-plate steels and heat treatments, and have resulted in significant betterment of endurance limit—to the extent of warranting the assumption that, in the present state of the art, the ideal link-plate analysis and heat treatment are closely approached—it is increasingly evident that a tremendous volume of fatigue investigation remains to be accomplished, because performance can be predicted neither on the basis of available literature nor from the usual information developed from static tests.

•

The Permeability of Porous Media To Liquids and Gases

L. J. KLINKENBERG (Shell Oil Development Co., Emeryville, Calif.)

THE standard procedure for determining the permeability of porous media according to A.P.I. Code No. 27 (first edition, October 1935) is based on the fundamental assumption that, as long as the rate of flow is proportional to the pressure gradient, the permeability constant of a porous medium is a property of the medium, and is independent of the fluid used in its determination. Although this is true of most liquids, the permeability constant as determined with gases is dependent upon the nature of the gas, and is approximately a linear function of the reciprocal mean pressure. This effect can be explained by taking into account the phenomena of slip, which are related closely to the mean free paths of the gas molecules. The apparent permeability extrapolated to infinite pressure gives a permeabil-

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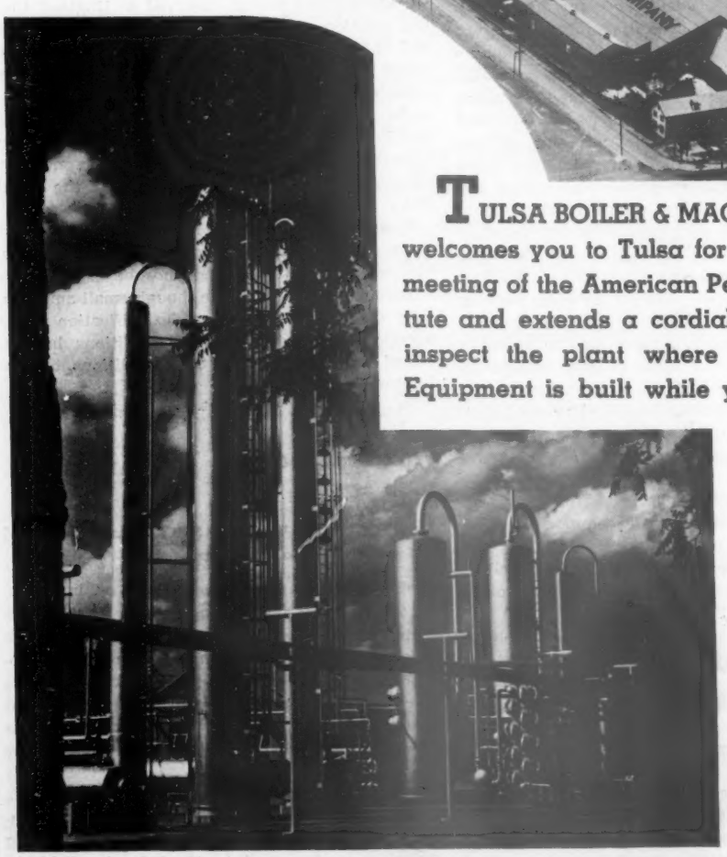

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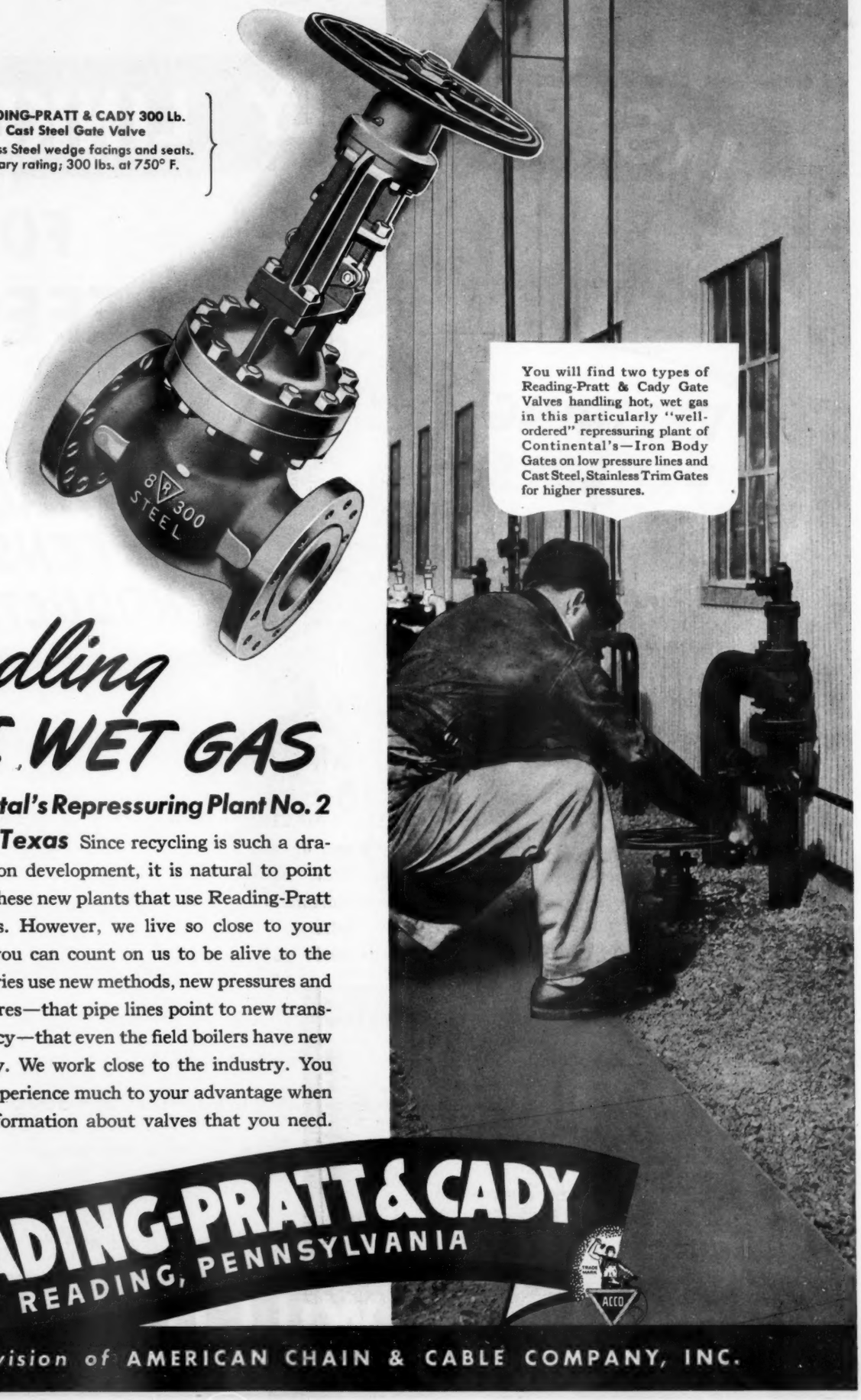
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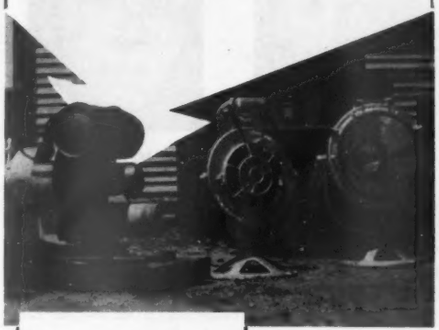

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ity constant which is a characteristic of the porous medium only.

Investigation has shown that the permeability to a gas is a function of the mean free path of the gas molecules, and thus depends on factors which influence the mean free path, such as the pressure, temperature, and the nature of the gas. Therefore, when the mean free paths are small, e.g., at high pressures, the permeability to gas should be expected to approach that for liquids. Experimental data which support these conclusions are presented by the author.

In order to test the conclusion that the gas permeability is a linear function of the reciprocal of the mean pressure, gas-permeability measurements were carried out at different pressures, from about 1 cm. Hg up to 20 atm. To verify the conclusion that at the same mean pressure the permeability is different for different gases, measurements were carried out with air, nitrogen, carbon dioxide and hydrogen.

According to an equation derived by the author, at a given pressure the apparent permeabilities for different gases should increase in the order of their mean free paths, which is confirmed by the present data. The same permeability for different gases, however, should be found if the permeabilities are compared at pressures when the mean free paths of the gas molecules are the same. As the mean free path is inversely proportional to the pressure, the same permeability for different gases will be found at pressures which are proportional to the mean free paths. For hydrogen, air, and carbon dioxide, for instance, the mean free paths of which are, respectively, $1{,}123 \times 10^{-8}$ cm, 608×10^{-8} cm, and 397×10^{-8} cm, the same permeability should be found at pressures in the ratio 1.85:1:0.65, or whose reciprocals are in the ratio of 0.54:1:1.54. The experimental results check this prediction quite closely.

Finally the apparent permeability extrapolated to infinite pressure is, within the experimental error, equal to the liquid permeability. This is illustrated in a table, in which the permeabilities at atmospheric pressure, the extrapolated permeabilities at infinite pressure, and the liquid permeabilities of a number of glass filters and core samples of different origin are given. That the gas permeability extrapolated to infinite pressure is equal to the liquid permeability is plausable, as the mean free path in the liquid state would be approached by that of gases at very high pressure.

It is evident from the foregoing results that the permeability as defined by A.P.I. Code No. 27 is dependent on the nature of the fluid used. As shown, however, it is possible to determine a permeability constant which is characteristic only of the porous medium, by taking into account the phenomenon of slip; experimentally this is done simply by extrapolating the gas permeability determined at various pressures to infinite pressure.

In the oil industry the permeability of core samples is measured to establish geologic correlation and for quantitative calculation of the production rate of producing strata. In these calculations several approximations have to be made, so that it is not necessary to know the permeability with a high degree of accuracy. In addition, an oil sand in general is not homogeneous with respect to permeability, so that it is necessary to average the values for a given productive interval; and, furthermore, the permeabilities as measured in the laboratory on samples which have been extracted and dried may not represent the formation as it exists underground, because of the shrinkage of clays or other hydrated materials.

It is, therefore, evident that the discrepancies between the permeability to liquid and the permeability to gas at atmospheric pressure are in many cases—at least for formations of moderately high permeability—not of first importance for prac-

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tical purposes. For formations of low permeability, however, although the absolute discrepancies may be small, the percentage differences are considerable, so that in these cases it is advisable to take into account the phenomena of slip.

●

1940 Road Detonation Tests

J. M. CAMPBELL (General Motors Corp.); R. J. GREENSHIELDS (Shell Oil Co., Inc.), and W. M. HOLADAY, (Socony-Vacuum Oil Co., Inc.)

OVER the past 10 years the Cooperative Fuel Research Committee, which is sponsored by the American Petroleum Institute, the Automobile Manufacturers Association, the Society of Automotive Engineers and the National Bureau of Standards, has given considerable attention to the problem of evaluating the knocking characteristics of motor fuels, both by laboratory tests and by actual road tests.

These tests indicate that the A.S.T.M. octane number alone, or even a road octane number as determined by methods heretofore widely used, does not give sufficient information to determine fuel behavior in service. New methods of approach have been developed to furnish this needed information.

The research program is being supported generously by the cooperating organizations. Various phases of the work have extended over most of the past year and in the concluding and most important stage—the centralized road tests at San Bernardino, Calif.—32 organizations were represented. In these concluding tests, a study was made of the characteristics of 23 fuels representing a wide variety of types and the complimentary behavior of 24 different automobiles. During this latter period alone, the test cars were driven more than 100,000 miles.

The report of the program to date is automatically divided into two parts, the cooperative road tests and the centralized road tests. The first part was designed to reveal differences in the test data supplied by various cooperating companies. On the basis of the response to questionnaires, a group of 15 fuels ranging from 70

R. J. GREENSHIELDS

W. M. HOLADAY

to 83 A.S.T.M. octane number was selected. The antiknocks test results varied widely among laboratories. For example, the 15 laboratories employing the original C.F.R. road-test method with minor changes show differences in the road ratings of individual fuels varying from 3.0 to 12.3 octane numbers. Because of this situation, a plan to conduct a series of centralized road knock tests at San Bernardino, Calif., was approved.

The purpose of these tests was to study cooperatively the problem of evaluating the knock characteristics of fuels and engines. Invitations to participate in these tests were sent out to the membership of the Cooperative Fuel Research Committee, the C.F.R. Motor Fuels Division, the C.F.R. Exchange Group and the Pacific Coast Technical Group. Invitations also were extended to the Ordinance Department and the Quartermaster Corps of the U. S. Army and to the principal manufacturers of ignition equipment and carburetors for passenger-car engines.

The following gasolines, representing a number of fuel types, were used in the tests:

(1) Straightrun plus catalytically cracked; (2) California straightrun; (3) Mid-Continent straightrun plus cracked; (4) catalytically cracked; (5) highly olefinic polymer; (6) mixed crude, highly aromatic; (7) Mid-Continent straightrun plus cracked reformed; (8) Mid-Continent cracked plus straightrun; (9) benzol blend, 40 per cent benzol; (10) two special blends of olefinic plus paraffinic fuels; (11) natural gasoline; (12) Mid-Continent cracked; (13) California cracked; (14) California straightrun plus cracked; (15) Paraffinic straightrun; (16) Mid-Continent straightrun plus cracked; (17) Mid-Continent straightrun; (18) 71-octane number reference fuel (A6 + C12); (19) 80-octane number reference fuel (C12 + F3), and (20) Mid-Continent straightrun plus alkylate.

In selecting the test cars an attempt was made to obtain a wide representation among 1940 and 1941 models, including from three to four different units of each make in the low-price group. As the engine speed at which a given fuel will knock in a given engine is determined by ignition timing, the problem appeared to resolve itself into a study of the relationship between ignition timing, engine speed and knocking tendency.

In order that the concepts involved in this new method of approach to the detonation problem be understood readily, a series of four illustrative diagrams was prepared. These represent typical relationships between ignition timing, engine speed, power output and fuel-knocking tendency. Their application is illustrated by graphs.

●

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O. F. CAMPBELL and T. B. KIMBALL (Sinclair Refining Co., East Chicago, Ind.)

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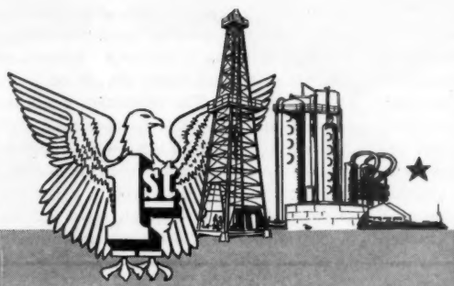

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ing-still furnaces, economies that may be effected by its use, daily operating data of this type of heat exchanger and the advantages and disadvantages of this type of exchanger heater. Comments are included with reference to air-heater corrosion, fouling, cleaning, heat absorption by oil tubes, more efficient heat distribution by use of forced preheated air, smoother still operation and repair and maintenance. Operating data covering several commercial installations are also included.

The Ljungstrom air heater operates on the continuous-counterflow-regenerative principle. The construction by which this continuous-counterflow-regenerative principle is applied includes the use of a slowly moving rotor containing the heating surface. Each revolution produces a complete cycle of heat exchange, in which heat from the hot flue gases is absorbed constantly by the metal plates and is given up to the air as the rotation moves the heated plates into the path of the combustion air. The housing of the heater is divided into two end compartments and a middle compartment, the latter containing the roto. The end compartments are divided by partitions, confining the flue gases to one side of the apparatus and the air to the other. Seals are used to keep to a minimum the leakage of air into flue gases.

It is generally conceded that, in the modern cracking-still furnace, the oil tubes located in the radiant section of the furnace absorb more heat per square foot of surface per hour than does the convection bank of tubes; and, therefore, it appears evident, from a maximum heat-absorption standpoint, using a minimum amount of surface, that all of the oil tubes should be located in the radiant section. The economy of eliminating the convection bank of a cracking-still furnace and substituting for it an air heater depends upon the cost of the convection bank, the cost of air heater and fans, the cost of power to drive the fans and price of fuel. Data given covering installations of downdraft de Florez heaters indicated that an all-radiant furnace, supplemented by a Ljungstrom air heater, is the more economical in both capital charges and operating costs.

In a conventional cracking still, wherein flue-gas temperatures may exceed 1,400° F. when the gas leaves the radiant section, the installation of a convection bank, supplemented by an air heater, might prove more economical than the installation of a high-temperature air heater requiring high-priced alloys in its fabrication. There are many cracking stills installed at the present time which, from a fuel-saving standpoint, could justify the installation of an air heater. There are, moreover, other advantages from the use of highly preheated air under forced and induced draft, such as a greater rate of radiant-heat absorption by the oil tubes, more uniform heat distribution in the furnace, lower flue-gas temperatures entering the air heater or convection bank, better flame control, less influence on oil-transfer temperatures from atmosphere changes, etc.

Disadvantages enumerated by the authors consisted of (1) the high power requirements for the forced and induced-draft fans, (2) air leakage, (3) wearing of seals so that they must be replaced from time to time, and readjusted as they gradually wear to keep leakage at a reasonable amount, and (4) care must be taken to avoid excessive accumulations of soot or sulfur deposits, which are liable to auto-ignition in case rotor stoppage occurs from power or from mechanical difficulty.

The advantages of the Ljungstrom air heater are many and varied, according to the authors. For equivalent heat recovery the Ljungstrom air heaters are smaller, more compact, and weigh less. Foundations and installation costs are low. They are cleaned readily, as the elements are short. During operation they are cleaned easily and effectively by steam or air-soot blowers, which are operated only a few minutes each day. The elements usually are cleaned at the end of each run by washing with warm water, or they may be washed with water during normal operation if provisions have been made to dispose of the wash water. When the heating surface is washed with water, the elements are washed until the wash water no longer shows acidity. In the event of a fire due to an oil-tube failure, the air heater can be protected effectively by the use of smothering steam. No air heater has been lost to date due to an oil-tube failure.

●

Fuel Economy in Refineries

D. C. LAWRENCE (Texas Co., New York)

BECAUSE fuel costs represent 20 to 30 per cent of total direct operating costs in an oil refinery, it is a very attractive field to attack in an effort to reduce operating expenses. Fuel is used to generate utilities and for process work. Fuel consumption is divided about equally between utility generation and process work. Inasmuch as generating facilities and the necessary operating personnel are centralized and operation is routine, the efficient generation of utilities should not present any particular problem. Usage of utilities is, however, a quite different problem. Products from the various processes change with consumer demand, seasons, etc., which vary the utility requirements, changing loadings on utility systems, individual drives, etc. To maintain a high efficiency in usage, constant modifications and changes are required.

Fuel consumed by the processes may be reduced by efficient heater design, by heat exchange from hot streams to incoming charge, to reboilers, to steam generators, to boiler feed water, etc.

Older generating plants, in many instances, can be replaced or supplemented with equipment of modern design at very attractive rates of return on the investment cost. This is due to increased

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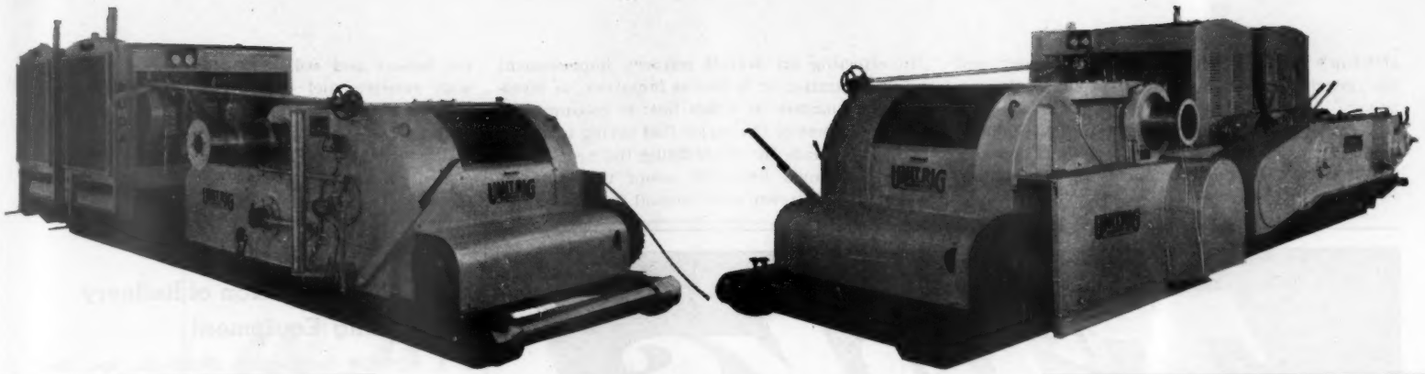

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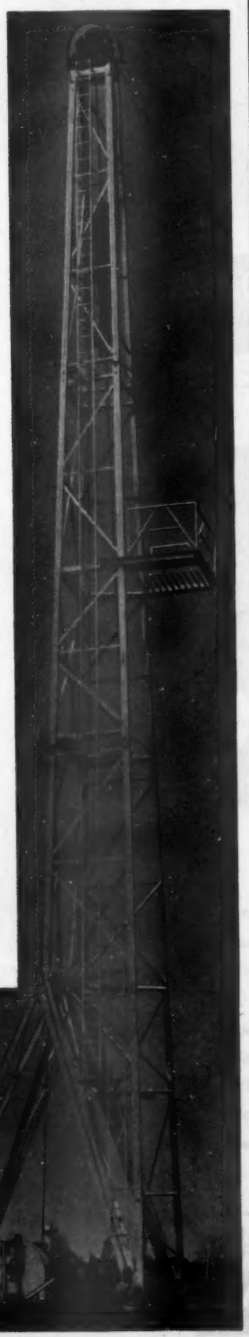

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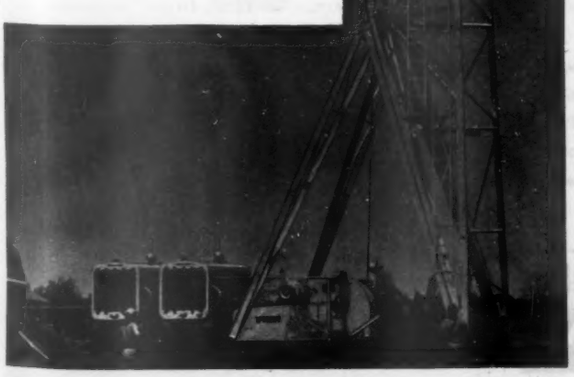

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May we refer you to one of the several fields in which you can see Unit Rigs in operation, or better still, may we show you through our modern plant where the outstanding features of several Unit Rig models may be carefully checked. Our plant is located in Tulsa on Archer, Denver and Elwood Streets. Please call any of the following so that we may take you through—George W. (Jack) Walton, Hugh S. Chancey, Wm. Guier, or Ray E. Carter—'Phone 5-3137.

UNIT RIG & EQUIPMENT CO.
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efficiency of the steam-generating equipment and the generation of low-cost byproduct electric power.

A recent installation of this nature was made in the Texas Co. refinery located at Port Arthur, Tex. *(See The Oil and Gas Journal March 3, 1940, Page 74.)*

In effecting an overall refinery improvement in fuel utilization, it is just as important to investigate the manner in which heat is consumed in the plant. Some of the major fuel saving in operation can be made by (1) utilizing the heat in the boiler blow-down line; (2) adopt the most efficient type of steam atomizing-oil burners under the boilers and stills; (3) familiarize operators with relative fuel costs; (4) install scavenger turbine drives where excess exhaust steam is available: (5) clean water lines; (6) adopt processing economies. Typical installations are discussed, including two-stage distillation and the recovery of heat from recirculating the reflux stream.

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Water-Side Corrosion of Refinery Condensing Equipment

B. B. MORTON (International Nickel Co., Inc., New York)

THE corrosion studied is confined to surfaces exposed to cooling waters. This corrosion may be viewed as directed and controlled by the three variables: aeration, temperature and velocity. A resume of certain theories of corrosion are offered. Corrosion that takes place in water, suitably contaminated to be a conductor of electricity, is referred to as "electrolytic."

In the presence of the electrolyte, a metal tends to go into solution, acquire a charge and become ionized. An airon nail placed in a copper-sulfate solution loses part of the iron to the solution. Copper, due to a loss of charge, will plate out.

Metals often corrode, i.e., go into solution, in a liquid that does not contain a replaceable metal. In this case it is the hydrogen ions, obtained by the dissociation of water, or acid, that plate out. Generally speaking, any material in the electromotive series will go into solution and acquire a charge from any other metal lower in the series and already in solution; e.t., all metals above copper will tend to dissolve into solutions containing copper, and metallic copper will plate out of the solution. Similarly, all metals above hydrogen will tend to dissolve and to plate out hydrogen from the solution.

The presence of dissimilar metals in contact in the presence of an electrolyte sets up a type of corrosion referred to as "galvanic corrosion." The outstanding feature of galvanic corrosion is that the differences in solution pressure, or potentials, of the two metals in a couple give rise to an electromotive force that increases the driving force behind the corrosion of the less-noble metal of the couple.

It has been noted that the products of corrosion tend to block and stop the reaction. For corrosion (of the type under discussion) to proceed, it is important that the hydrogen be removed from the cathode surface, otherwise, hydrogen can block the corrosion reaction.

The formation of hydrogen gas does not proceed smoothly, even when the theoretical driving potential is present. In such a case, a greater potential is required and the extra potential required for the evolution of hydrogen is called "over-voltage." The over-voltage required varies with different metals as well as with the conditions of their surfaces.

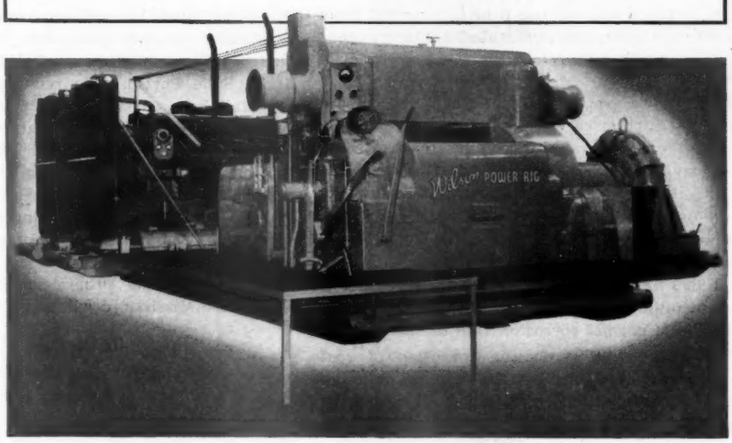
It should be noted that an evolution of hydrogen only occurs during corrosion when there is a concentration of hydrogen ions, as in the case of a highly ionized acid which is reacting, or when a large driving force or potential is acting.

It is important to note that the tendency for a metal to corrode often is controlled by the rate at which the material deposited at the anode is removed. An example is lead, because the formation of insoluable lead sulfate on the metal retards corrosion and renders lead a useful material for contact with sulfuric acid.

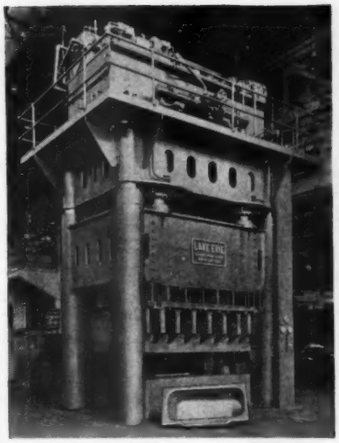
In continuation of the above, it should be

IN THE NEWS

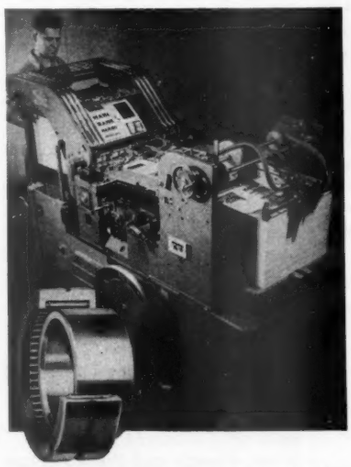
WITH BANTAM BEARINGS



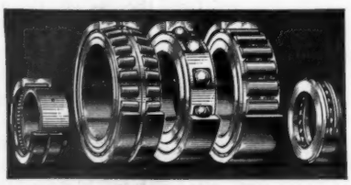
ECONOMICAL DRILLING of wells of any required depth is made possible by the modern design of the power rigs built by Wilson Manufacturing Co., Inc. Typical of the drilling potentialities of the Wilson line are the Giant, Atlas, and Titan Models, with rated capacities of 6,000, 8,000, and 12,000 feet, using 4½" drill pipe. Bantam Bearings are functioning successfully and economically in clutches on the drum shafts of these models. Other Bantam Bearings are serving the oil industry in pumpers, rotaries, swivels, and crown and traveling blocks.



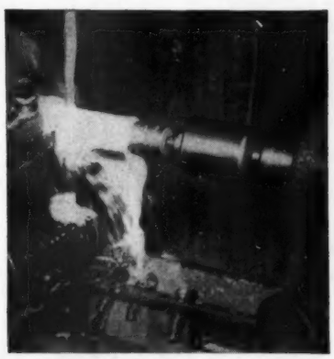
THIS 1700-TON FORMING PRESS is powered by two variable displacement pumps manufactured by The Oilgear Company and equipped with large-size Bantam Radial Roller Bearings, 12.5984" and 16.5354" O.D. Here is a typical instance of the ways in which heavy-duty Bantam Bearings are serving industry in exceptionally severe applications.



NEW PRODUCTION RECORDS are being set by the Kelly Clipper Printing Presses manufactured by American Type Founders. Bantam Quill Bearings are used on planetary gear and crosshead crank pin of the bed motion of these up-to-the-minute presses. Bantam also serves the builders and users of printing presses with other types of bearings specially designed for high-speed rotation.



EVERY MAJOR TYPE OF ANTI-FRICTION BEARING is included in Bantam's line—straight roller, tapered roller, needle, and ball. Bantam engineers, with their broad background of experience in bearing design and application, recommend the type that best suits *your* needs—or design special bearings to meet unusual conditions. If you have a difficult bearing problem, TURN TO BANTAM.



HIGH CAPACITY IN A SMALL SPACE is secured in the live centers built by Motor Tool Manufacturing Company through the use of Bantam Quill Bearings. For additional information on this compact anti-friction bearing, write for Bulletin **J-104**

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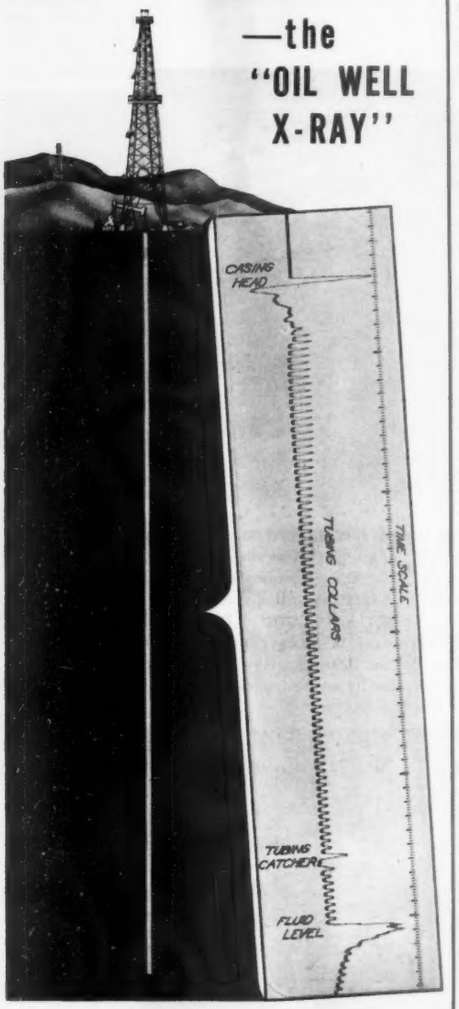

"Out of the Night"

There was a time when operators were pretty much in the dark as to what was going on in their pumping wells. Now it is no longer necessary to work in the dark, as DEPTHOGRAPH well testing has been developed to eliminate this hazard. Depthograph operating fluid level measurements throw much light on what is going on in your wells. Bottom-hole pressure tests give you more exact information, and potential tests tell the whole story of the characteristics of your well and its production capacity.

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pointed out that aluminum and high-chromium alloys are rendered resistant to corrosion by a number of reagents if first treated with an intensely oxidizing acid or solution. The corrosion products—oxide films—usually have a lower solution pressure than the metals from which they are formed and consequently while intact confer upon the metal an artificial degree of "nobility."

However, discharge of hydrogen at the cathode areas brings about a depletion of the hydrogen ions. This in turn results in the solution at the cathode areas becoming more alkaline, due to concentration of hydroxyl ions. Frequently the effect of alkalinity is to result in the precipitation of insoluble, protective corrosion products, as in the case of iron.

Cast iron long has been used as the material for condensers. The chief merit dictating the use of cast iron is the graphitic form the corrosion of this material takes. In this type of corrosion much of the ferrite of the iron is removed from the affected zone, leaving behind a black porous structure which may retain the form of the original metal.

The layer of graphitized material may decrease or prevent further corrosion of the cast iron. This occurs when the graphitic coating reaches some depth and the pores are clogged with insoluble matter. Under these conditions cast-iron parts may outlast steel parts for a long time.

Whereas the graphitic layer on cast iron often acts as a deterrent to corrosion, it must be recognized also that this layer is quite noble compared with metallic cast iron and, therefore, can accelerate the normal corrosion rate of the iron.

Two methods of combating corrosion of cast iron appear available by the use of alloying agents. Small additions of nickel and nickel with chromium have served to reduce corrosion rates of cast iron by such physical means as refining the grain, reducing the graphite particle size and limiting porosity.

A very large tonnage of admiralty metal also goes into the condensing equipment of refineries. This alloy has performed, in general, in a most creditable manner and promises to hold its position for some time to come, especially in view of the results obtained from the use of inhibitors in the alloy.

Admiralty metal (70 per cent copper, 20 per cent zinc and 1 per cent tin) appears under appropriate conditions to suffer from three distinct types of attack on the water side. These are dezincification (general and plug types), pitting (frequently at break in deposits), and impingement attack (at inlet ends at high velocities). When failure does not occur due to these forms of attack, there naturally occurs a general thinning over an extended period of time.

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Recent Increase in Drilling May Bring Year Above 1940

(Continued from Page 41)

state show declines over last year but the fact that April was the largest month in all areas except the upper Gulf Coast district indicates the probability of a reversal in many sectors. The shallower fields in North Texas are receiving much attention while West Central Texas also shows frequent localized spurts of activity. The situation in the Panhandle is brighter than the first 4 months' record show as more new locations were recorded during the first 2 weeks in May than during any 2-week period since the 1927 boom. West Texas has much more inside drilling in Wasson, Slaughter and Seminole as well as in the older fields in the southern sector.

Hawkins is providing much of the activity in East Texas although there is an upward trend in drilling in the East Texas field as more operators find the need of offsetting wells a few feet away. The upper Gulf Coast has settled down to routine activity except in Jackson County where there is much drilling in West Ranch and Lolita. West Ranch was just as active last year, but Lolita was not yet discovered. Southwest Texas has been much less active than last year but April's record showed a decided increase. On the lower Gulf Coast, the hot spots are Stratton and Agua Dulce where distillate pays have become oil sands downstructure. In the Laredo district, Colorado and Rincon continue active.

Louisiana and the Southeast

In the Louisiana Gulf Coast district, activity continues well below last year's level. There are many wells to be drilled but operators are deterred by the excessive depths of current developments. In North Louisiana, drilling is at about the same level, but whereas most of it was in the Caddo area last year, this year's drilling includes the newly discovered Wilcox production in La Salle Parish. The remainder of the year may fall below last year in this district unless developments in the near future are more encouraging than those of the past few months. Arkansas is comparatively inactive. The Mississippi play is running ahead of last year but the drilling is more concentrated in Tinsley where the south end was reached a couple of weeks ago. Activity here will possibly decline unless the state abandons the 40-acre spacing principle, in which case Mississippi will show a great increase.

Rocky Mountain Area

Montana and Colorado show considerably more activity than last year, due in great part to the development of gas fields. Wyoming, on the other hand, is steadily declining as Lance Creek is proved up and other fields are attracting little attention. A price increase would start drilling, especially in the heavy-oil fields where there is a great deal of undrilled but proven acreage awaiting attention. The activity in the Maljamar and Eddy County fields which provided most of New Mexico's activity last year has very largely subsided. Better marketing conditions could revive this drilling also as there is still much undrilled proven acreage.

California

California is not expected to show much greater activity during the year unless the Inglewood and Dominguez deep zones develop into town-lot plays. The Ford zone at Wilmington is also a potential active area as soon as some operator steps in and opens it up. There is also the possibility that some fields now on 20-acre spacing will drop to 10 acres. The present outlook, however, is for California to fall slightly below the 1,000-well mark this year.

Conclusions

The search for gas, increased prices and the discovery of new pools in Illinois have reversed previously expressed predictions that drilling in this area will fall below last year. Instead, it now looks as if it would run higher. In the Mid-Continent, Kansas, and North Central and East Texas will probably show increases.

Southwest Texas and the Panhandle also appear to have a good chance of exceeding last year's record. In the Rocky Mountain area, Montana will probably continue to forge ahead.

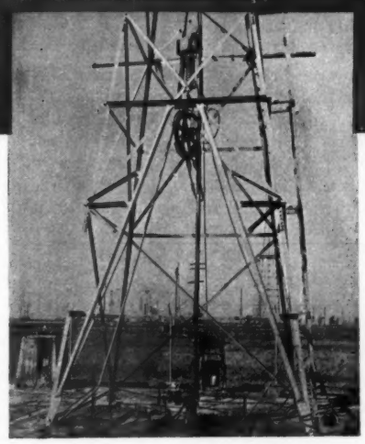
A continuation of the present trend of rising prices will undoubtedly spur activity, particularly in Kansas, Wyoming, New Mexico and West Texas where there is an opportunity to increase production with a minimum of risk. California and Mississippi owe much of their chances for more drilling to spacing changes which are now under contemplation. All told, the prospects are that drilling during 1941 will approximately equal that of last year.

Here's why you can Rely on LANE-WELLS

Lane-Wells accepted the responsibility of leadership with the introduction of Gun Perforator Service more than eight years ago. Since then the entire organization—Field Men, Engineers, Shop Employees and Officials—has worked together constantly, improving equipment and widening the scope of operations to keep pace with the ever-increasing demands of oil well operators for Technical Oil Field Services designed to increase ultimate well production and lower production costs. From the Lane-Wells plant has come the finest service equipment and tools possible to build. In the shops of Lane-Wells Branches this equipment is checked and calibrated regularly to maintain it at peak efficiency. In the field Lane-Wells Units are operated by careful, experienced crews who understand local field problems and are trained to work to the best advantage with the operator's crew to "get the job done right."

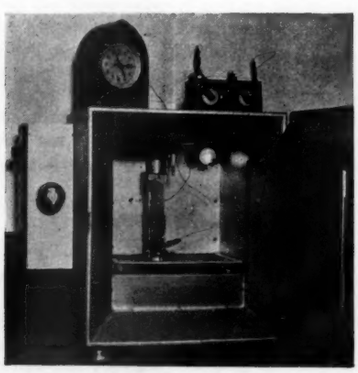
Lane-Wells progress has been steady and sure—made possible by the wholehearted acceptance and cooperation of more than 2800 oil companies in the United States.

To the Petroleum Industry the Lane-Wells organization of more than 400 members makes this pledge: "To provide service of unvarying accuracy, unexcelled efficiency and unquestioned reliability, as our part in the advancement of America's most important industry."

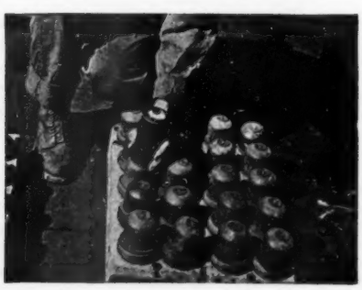


Test wells in each of Lane-Wells Divisions enable the accurate calculation of cable operating characteristics. Gun Perforator and Electrolog cables are thoroughly seasoned before being released for field service.

Lane-Wells Photo-Record Magnetic Single-Shot Survey Instruments accurately record inclination, direction or both in drilling wells. Each instrument passes exhaustive tests for accuracy before it is released to the field.



The clocks of Lane-Wells Multiple Shot Survey Instruments must not vary more than one second in one hour, within temperature variations of 50° F. to 250° F.



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Mud Flow in Drilling

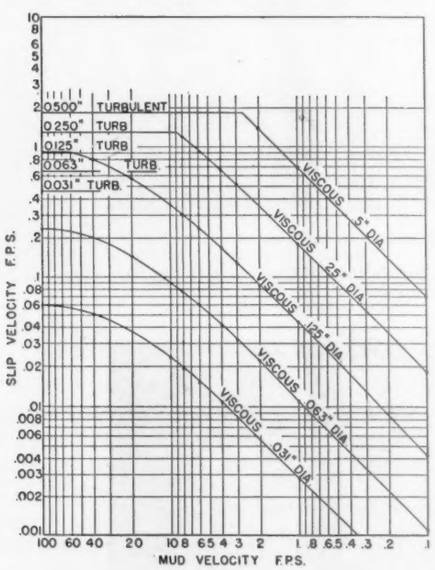
(Continued from Page 64)

cause hangups. It has been found from dredging experience that concentrations of 5 per cent of cuttings in a fluid are safe, but higher values may cause jamming.

Space herein does not permit going into all the figures, but in the earlier report mentioned heretofore it was shown that, at low velocities, concentration might exceed 5 per cent at 200 ft. per day, and easily could exceed 5 per cent at 700 ft. per day, especially for lighter muds with less lifting capacity.

In general, it is apparent that, as the hole is deepened, the danger lies in any *enlarged* sections where the velocity is reduced. The best method, so far as lifting cuttings is concerned, is reversed circulation, because the velocities are always higher in the drill pipe than anywhere else, and the pipe is the same size all the way up, so that there is no chance of dropping out cuttings that have once been started up. There are, of course, objections to this method due to conditions other than the lifting of cuttings.

In computing the fall of cuttings, it is necessary to take note of the fact that, for the particles 0.125 in. and smaller, the normal slip is viscous to quite high velocities. However, if the mud stream breaks over into turbulent flow, as it does at moderate velocities, the particle no longer can fall in viscous flow, and jumps at once to the turbulent value. For example, a ½-in. cutting may be falling in turbulent slip due to its own speed while the mud in the hole might be in viscous flow; but, with the main mud flow turbulent, the chip must follow also the turbulent-region law. This situation gives rise to a discontinuity, and the slip of the cutting in many cases will be higher than in viscous flow. For example, No. 1 mud, 4.29 ft. per second, in 7-in. hole, 4½-in. drill pipe, an 0.063-in. cutting would fall, in viscous flow of the mud, at 0.022 ft. per second; but as the main flow is turbulent, the particle is in turbulent slip at 0.25 ft. per second. The matter is not very important, as in all such cases the slip is quite low for both conditions.



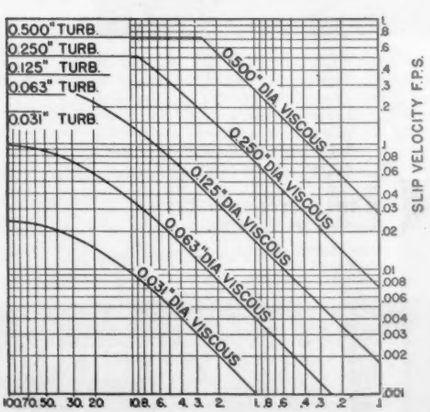


Fig. 13 (top)—Slip velocity, mud No. 1—round cutting. Fig. 14 (bottom)—Slip velocity, mud No. 1—flat cutting

TABLE 5—VISCOUS SLIP, MUD NO. 2

Mud velocity (ft. per sec.)	Diameter of cuttings (inches) 0.50	0.25	0.125	0.063	0.031
	Round Particles				
0.1	*NR*	*NR*	0.043	0.011	0.003
0.3	*NR*	*NR*	0.129	0.033	0.008
0.5	*NR*	*NR*	0.220	0.055	0.013
1.0	*NR*	*NR*	0.430	0.110	0.027
2.0	*NR*	*T*	0.800	0.200	0.051
3.0	*T*	*T*	*T*	0.290	0.071
4.0	*T*	*T*	*T*	0.360	0.090
6.0	*T*	*T*	*T*	0.480	0.122
8.0	*T*	*T*	*T*	0.570	0.144
10.0	*T*	*T*	*T*	0.630	0.158
	Flat Particles				
0.1	*NR*	0.070	0.017	0.004	0.001
0.3	*NR*	0.200	0.051	0.013	0.003
0.5	*NR*	0.340	0.085	0.022	0.005
1.0	*T*	*T*	0.170	0.043	0.010
2.0	*T*	*T*	0.310	0.078	0.020
3.0	*T*	*T*	*T*	0.112	0.028
4.0	*T*	*T*	*T*	0.140	0.035
6.0	*T*	*T*	*T*	0.190	0.047
8.0	*T*	*T*	*T*	0.220	0.056
10.0	*T*	*T*	*T*	0.240	0.061

T indicates turbulent fall, see Table 6.
NR indicates nonrising slip greater than velocity of mud.

TABLE 6—TURBULENT SLIP

	Diameter of cuttings (inches) 0.50	0.25	0.125	0.063	0.031
	Round Particles				
No. 1 mud	1.85	1.30	0.92	0.65	0.46
No. 2 mud	2.06	1.45	1.03	0.73	0.51
Water	2.30	1.62	1.15	0.81	0.57
	Flat Particles				
No. 1 mud	0.72	0.51	0.36	0.25	0.18
No. 2 mud	0.80	0.56	0.40	0.28	0.20
Water	0.90	0.63	0.45	0.32	0.22

TABLE 7—VELOCITIES AT CIRCULATION OF 300 G.P.M.

Inside diameter of hole (inches)	Outside diameter of drill pipe (inches)	Net area (sq. ft)	Velocity (ft. per sec.)	Area of drill-pipe inside diameter (sq. in.)	Drill-pipe velocity (ft. per sec.)
18	6⅝	1.528	0.438	0.2003	3.34
10	6⅝	1.306	2.190	0.2003	3.34
10	4½	0.435	1.540	0.0798	8.39
7	4½	0.156	4.290	0.0798	8.39

Dropping Cuttings

It is easy to perceive, from a study of the slips and change of viscosity, that the mud ditch is a better place than the pit for separation. If the ditch is pitched so that the velocity is just above the critical, chips will drop easiest, as the apparent viscosity is down to a very low value, and the velocity is the lowest that will obtain this low value; and, further, the mud velocity is substantially horizontal, so that it does not sustain the cuttings. These are carried along horizontally, but the full slip value is usable for dropping the cuttings out of the stream. The flow in the ditch can be kept shallow, so that cuttings have only a short distance to fall. . . .

Referring to Figs. 13, 14, 15, and 16, showing slip velocities, it will be noticed that, in Figs. 15 and 16, the 0.500-in. cuttings show no viscous-region slips. This is because the mud velocity is less than the slip velocity, and the chip will not lift at all until the turbulent condition has been reached.

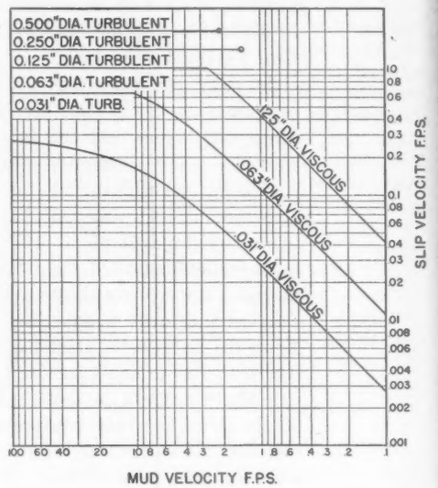
The general conclusions are:

1. The pressure drops and the sustaining effect of any mud can be computed quite accurately, given the complete viscosity-velocity relations and density of the mud.

2. Attention should be given to balancing pressure drops as between drill pipe and hole, whenever feasible, to keep the total pressure in the pumps down.

3. Velocity is useful for lifting, but is limited by the pump pressures required. Reasonably high density is valuable for lifting, but also opposes dropping cuttings.

4. Viscosity is generally objectionable; it raises pumping pressures; and because in muds it is practically inversely proportional to velocity in the viscous region (mud pit), it is the most serious obstacle to dropping cuttings. Gelling to sustain cuttings when circulation is stopped now is obtained easily without high apparent viscosity in motion. . . .



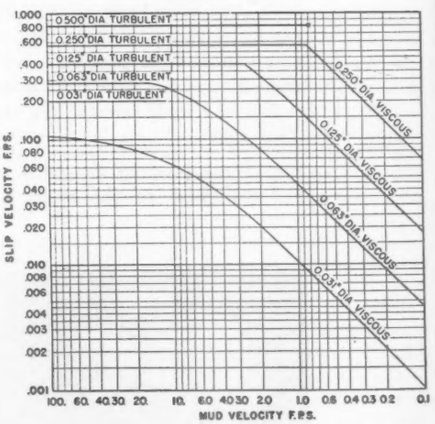


Fig. 15 (top)—Slip velocity, mud No. 2—round cutting. Fig. 16 (bottom)—Slip velocity, mud No. 2—flat cutting

Acknowledgment

The writer wishes to acknowledge gratefully the assistance of R. L. Chenault in recalculating the flow values from the 1931 report, for the different conditions selected, and for differences in size of string combinations.

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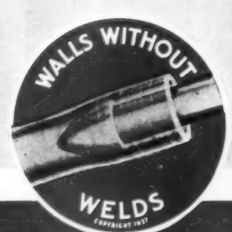

Walls without Welds

Use of Depth-Pressure Data in

The Determination of Well Potentials in California

By R. W. FRENCH,* M. W. MORRIS,† E. G. TROSTEL,‡ and J. C. YOUNG§

CURTAILMENT in California has been made possible through the voluntary cooperation of the great majority of oil producers. The method of allocating production has varied from time to time to suit changing conditions, and in May 1939 a uniform system[1] was adopted giving each well in the state an allotment based primarily on its individual well potential. This additional emphasis on individual well potentials, which previously had been set solely by demonstrative tests, led to the adoption of an alternative method for potential determination based upon subsurface-pressure measurements. . . .

It is the purpose of this paper to discuss the operations of the depth-pressure system since its final approval in November 1939. . . . Data are presented to show the relative accuracy of the test methods, their economic value to the industry, and the degree of their acceptance by operators. Specific problems of an engineering nature have arisen from the interpretation of depth-pressure data; these are discussed, together with the methods of approach used in attempting their solution.

Appraisal of Operation of the Depth-Pressure System

Comparative tests.

The introduction of a new method of setting potentials immediately raised a question as to its accuracy. Some operators, unfamiliar with the measurement and application of subsurface pressures, viewed the new procedure with misgivings, and feared the possibility of inflated potentials. A series of tests was made under the sponsorship of the oil administrator's office to check the accuracy and dependability of potentials set according to the new rules and regulations. Table 1 shows the results of tests, comparing potentials of flowing wells set by the depth-pressure method and subsequently ascertained by demonstration. In no case was any demonstrated rate lower than the corresponding discounted potential, if correction was made to the 30 lb. per sq. in. standard surface pressure, although there were several rates in excess of the calculated potentials. Wells designated as 1, 5, 6, and 8 produced at a greater rate than calculated, due to a marked reduction in vertical-flow pressure loss at the demonstrative rate. The failure of well No. 4 to demonstrate its calculated potential illustrates the hazard of excessive extrapolation and the effectiveness of the discount formula.

TABLE 1—COMPARISON OF CALCULATED POTENTIALS WITH SUBSEQUENT DEMONSTRATIVE TESTS (FLOWING WELLS)

	Depth-pressure test					Demonstrative test		
		Highest test rate						
Well No.	Productivity Index (bbl./day/(lb./sq.in.)	Rate (bbl./day)	Per cent of calculated potential	Calculated potential (at 30 lb. tubing pressure) (bbl./day)	Discounted potential (bbl./day)	Rate (bbl./day)	Tubing pressure (lb./sq.in.)	Length of test (hours)
1	0.47	208	82	253	253	306	70	24
2	0.84	314	65	484	484	493	80	24
3	1.26	227	64	355	355	426	25	24
4	1.90	187	29	645	481	488	10	24
5	1.64	681	29	2,340	1,715	2,417	180	24
6	1.83	585	25	2,300	1,535	2,304	225	24
7	3.30	980	68	1,450	1,450	1,242	260	60
8	1.46	270	37	740	626	997	40	24
9	0.41	332	81	409	409	397	72	72

Note: All production data are in terms of gross liquid.

The data in Fig. 1 pertain to an actual well which was produced later at higher rates, as illustrated in Fig. 3. Verification of the accuracy of the pressure-rate-curve extrapolation was obtained, although in this example a decrease in the vertical-flow pressure loss with increasing rate was observed again.

Table 2 relates the potentials of pumping wells as set by pressure data and confirmed by actual demonstration. It will be noted that the wells under demonstrative test seldom approached the calculated potential, although they produced more than the discounted potential in every case but one. Well No. 7 failed to produce its discounted potential, but a subsurface-pressure record revealed that the well was but 75 per cent pumped off during the demonstrative test because of inadequate pumping equipment.

The determination of pressures in pumping wells from fluid-level measurements was a relatively new procedure, whose accuracy was verified by simultaneous pressure measurements with a recording gage run below the pump. In all cases the values checked closely. . . .

Special Studies and Problems

As in the case of any application of new engineering regulations to problems of wide scope, it was inevitable that many special problems, odd circumstances, and specialized approaches should appear. This was realized from the beginning, and provision was made for flexibility through individual investigations by the depth-pressure ad-

*Continental Oil Co., Los Angeles, Calif. †Standard Oil Co. of California, Los Angeles, Calif. ‡United Oil Co. of California, Santa Fe Springs, Calif. §Conservation Committee of California Oil Producers.

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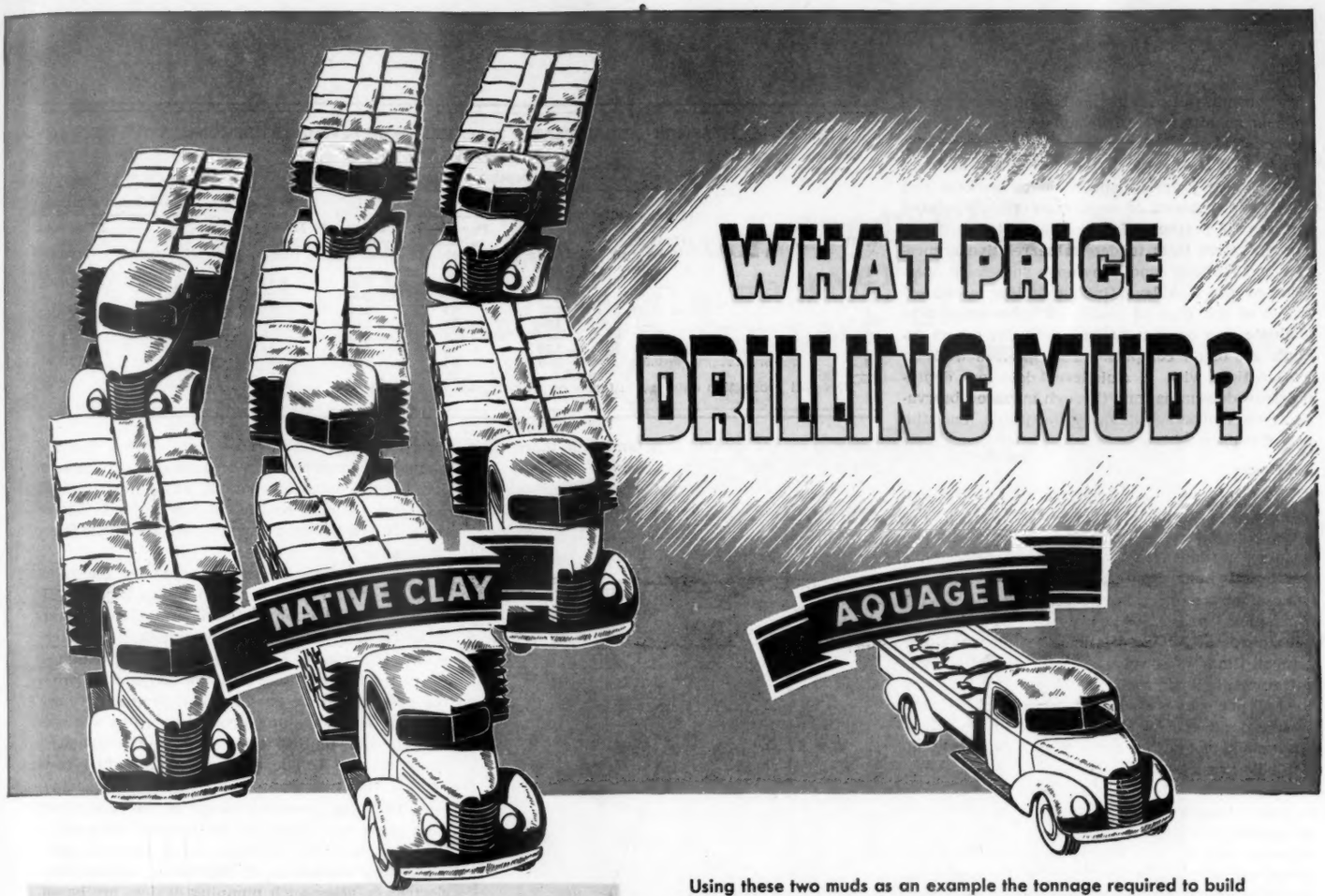
M. W. MORRIS

J. C. YOUNG

Well potentials for use as the primary factor in allocation under the California "uniform method" are being established successfully by depth-pressure means in flowing, gas-lift, and pumping wells. Hazards of extrapolating the mean producing pressure-rate curve are discussed, and minimum practicable mean producing pressures are calculated within conservative limits. Present status of special studies is given, covering such topics as critical sand entry, pump capacity vs. depth, sonic-method tests, hydraulic unit tests, and gradient determination and estimation both in tubing and in the annulus. Acceptance of the depth-pressure method is general, but there is no evidence of a sudden swing toward it as an alternate to open-flow tests, nor is there any tendency for it to cause inflation of state potential. Incidental value of this work is great in widening circle of operators who are familiar with this analytical method, and in promoting more general acceptance of reservoir-behavior concepts.

The accompanying article is abridged from the paper presented before the Division of Production, at the midyear meeting of the American Petroleum Institute, Tulsa, May 19-22, 1941.



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AQUAGEL-water mud deposits a filter cake about ⅛" thick. The total amount of this filter cake in a 5000' well will occupy a volume of 165 cubic feet made up of 7% solids by volume (12 cubic feet of solids). At 2.5 specific gravity the weight of these solids will be 1800 pounds and will use up only 18 sacks of AQUAGEL for the filter cake.

Using these two muds as an example the tonnage required to build the filter cake alone on the walls of the hole is 35 times more in the case of the native mud than the AQUAGEL required. This extra unnecessary cake thickness is not only expensive but detrimental to drilling operations and may cause stuck tools.

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visory committee. As this method of setting potentials is an alternate to demonstrative tests, any case resolving into an unapproved exception still can be handled by the latter method. Periodic review of past progress, special investigations, and subsequent revision of requirements were pointed out as vital portions of the whole system.

Cooperative tests to determine relative accuracies and limiting conditions upon successful operation of two fluid-level-finding devices is one example of the type of test work accomplished to evaluate new equipment and methods; others include use of air compressors on gas-free wells in conjunction with a fluid-level detector, depth-pressure determinations through surface observations on hydraulic pumping apparatus, and the use of copper tubing and surface gage.

Sand entry.

The limitation of critical sand entry upon the obtainable portion of the potential calculated from a depth-pressure test is an important and, as yet, unsolved problem. At an early date the committee investigated this difficulty, looking toward some empirical solution. Neighboring wells, with a common producing interval, were found to behave differently with reference to the maximum rate of fluid withdrawal free of excessive sand entrainment. Some wells could produce at more than 60 per cent pressure drawdown, without excessive sand cut; whereas others, in the same sand, could not utilize more than 15 per cent of available pressure differential.

Consideration of the various determinants, such as sand characteristics, perforation design, well-completion procedure, fluid gravity, velocity, gas-oil ratio, etc., to date has yielded no correlation which will allow close prediction of the maximum sand-free production rate. This problem is of particular concern in the prolific Wilmington field, but there are few other California fields in which it constitutes a grave difficulty. Final judgment of the probable safe maximum rate allowed such a well is made by staff engineers of the oil administrator's office based upon experience.

Maximum capacity of sucker-rod pumping

Pursuant to the stipulation that no potential should exceed the actual productive capacity of the well using the same type of equipment installed during the test, a ceiling curve for rod pumping equipment was adopted. This curve represents the limiting productive capacity for any rod well depending upon effective depth of pumping fluid level. As may be seen in Fig. 4, any well pumping from a fluid level of 8,000 ft. or lower may not receive a potential of more than 200 bbl. per day.

The curve is not based on any one theoretical analysis nor on any particular limiting rod stress, but represents a boundary delineation of actual well observations made by various California operators, consideration of approved theoretical aspects, and generally accepted views of good practice. Twice revised, the curve faces further change as experience is accumulated. To date it has been invoked in about 25 cases in a total of 537, and no well so limited has proved that it actually can produce beyond the rate taken from the curve.

TABLE 2—COMPARISON OF CALCULATED POTENTIALS WITH SUBSEQUENT DEMONSTRATIVE TESTS (PUMPING WELLS)

	Depth-pressure test					Actual demonstration	
		Highest test rate					
Well No.	Productivity index (bbl./day/lb./sq.in.)	Rate (bbl./day)	Per cent of calculated potential	Calculated potential (bbl./day)	Discounted potential (bbl./day)	Rate (bbl./day)	Length of test (hours)
1	4.55	492	96	513	512	509	24
2	0.34	118	65	182	159	164	120
3	0.34	236	61	386	329	354	72
4	0.53	175	37	469	284	300	528
5	0.21	169	61	275	233	248	24
6	1.79	500	39	1,277	804	850	24
7	0.75	148	46	347	245	230	72
8	0.34	118	65	182	159	165	120

Note: All production data are in terms of gross liquid.

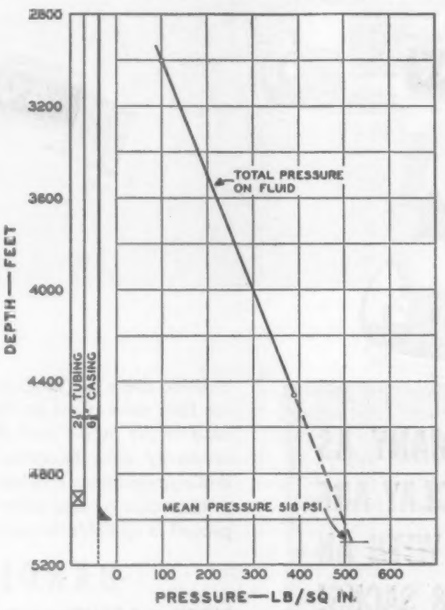


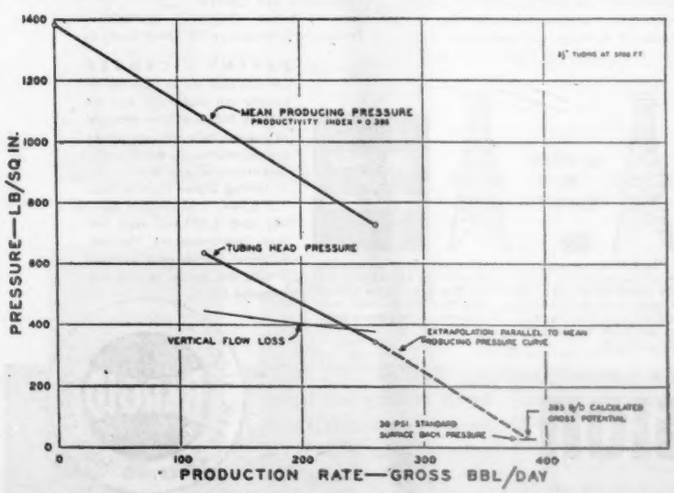
Fig. 2—Example of mean-pressure determination from fluid-level measurements by the sonic method

Limiting capacities of hydraulic, submersible-electric, or other such pumping devices are based in each case on actual volumetric efficiency observed during the test, largest applicable size of unit, and accepted top operating speed.

Water-cut evaluation.

In extrapolating fluid production rates for wet wells, the question of cut behavior has constituted another problem. Although the water percentage increases with gross rate in certain areas, it has the opposite tendency in others. Variation in performance of otherwise similar wells is not uncommon, and precise prediction of cuts at higher rates is not always possible.

However, in two areas of similar characteristics, an apparent relationship between sustained water percentage and cumulative oil production of the individual wells seems to give consistent



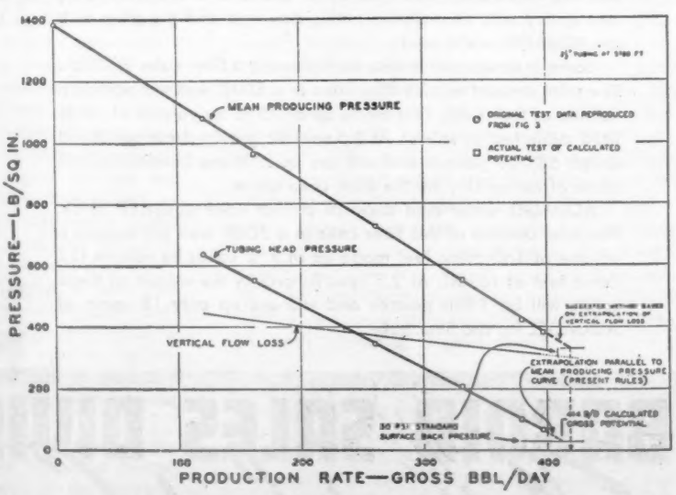


Fig. 1 (left)—Example of the graphical method of potential determination for a flowing well. Fig. 3 (right)—Example showing mean producing pressure measured near the calculated potential rate in a flowing well. All points of subsequent test fall along the pressure-rate curve established by the original test shown in Fig. 1. The method of extrapolating vertical-flow loss to higher rates is illustrated

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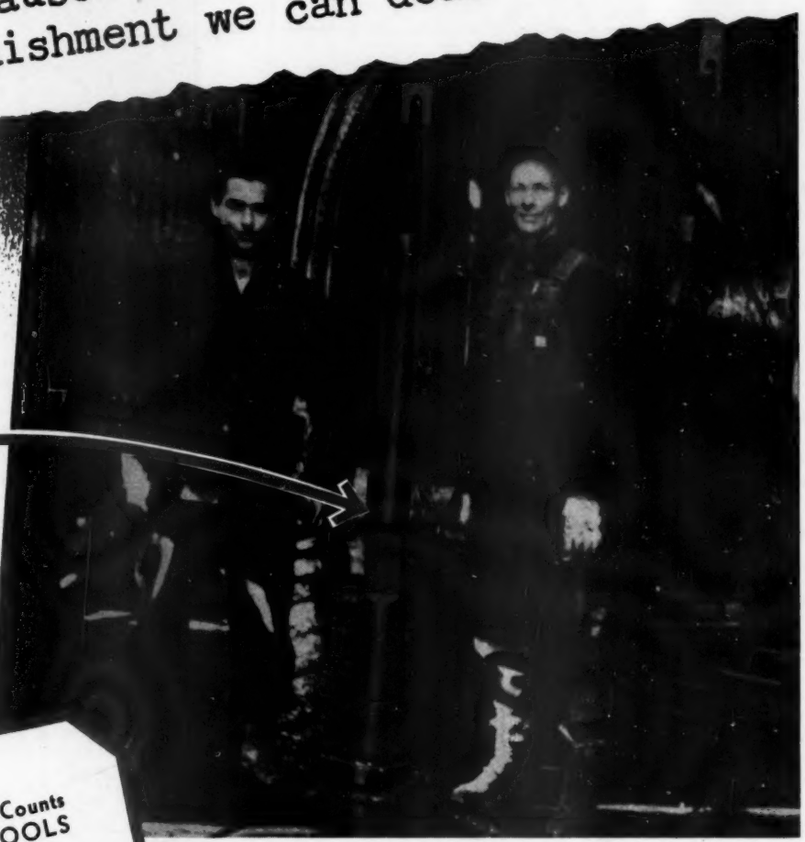

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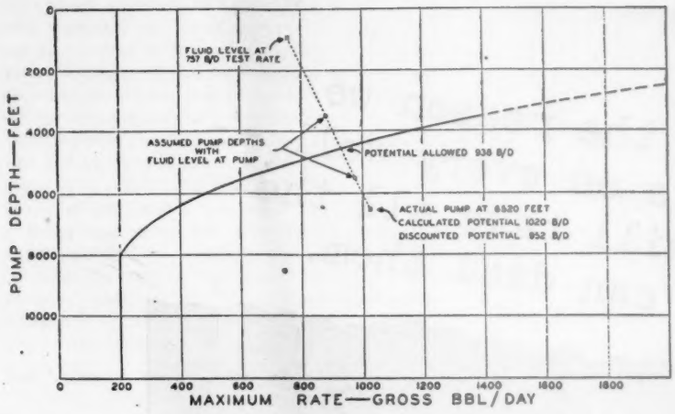

FLUID LEVEL AT 757 B/D TEST RATE
ASSUMED PUMP DEPTHS WITH FLUID LEVEL AT PUMP
POTENTIAL ALLOWED 938 B/D
ACTUAL PUMP AT 6520 FEET
CALCULATED POTENTIAL 1020 B/D
DISCOUNTED POTENTIAL 952 B/D
PUMP DEPTH—FEET
MAXIMUM RATE—GROSS BBL/DAY

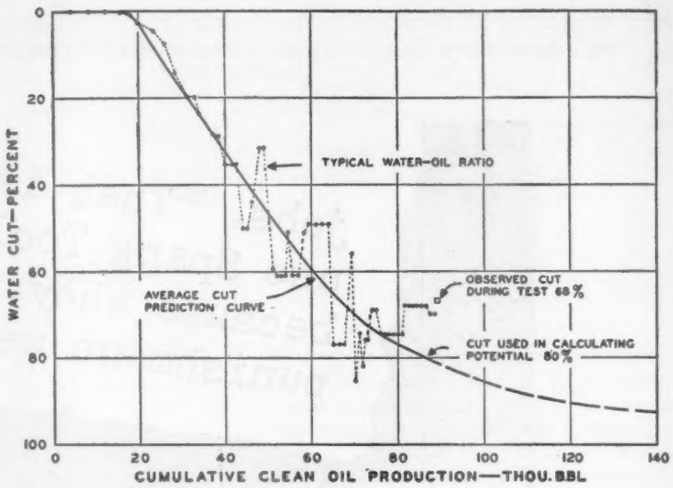

TYPICAL WATER—OIL RATIO
AVERAGE CUT PREDICTION CURVE
OBSERVED CUT DURING TEST 68%
CUT USED IN CALCULATING POTENTIAL 80%
WATER CUT—PERCENT
CUMULATIVE CLEAN OIL PRODUCTION—THOU. BBL

Fig. 4 (left)—Tentative maximum-capacity curve for sucker-rod pumps. Example shows method of application to potential limitation. Fig. 5 (right)—Characteristic curve showing water vs. cumulative oil production of a well in a San Joaquin Valley field

results, allowing prediction of true cuts independent of rate. A study of production records from several contiguous operators confirmed the evidence that the performance of most wells conforms to a characteristic curve, as illustrated in Fig. 5. Regardless of deceptive cuts shown on short-period tests, the proper well cut, as checked by continuous operation of representative wells, could be estimated from the trend of water-oil ratio vs. cumulative oil production.

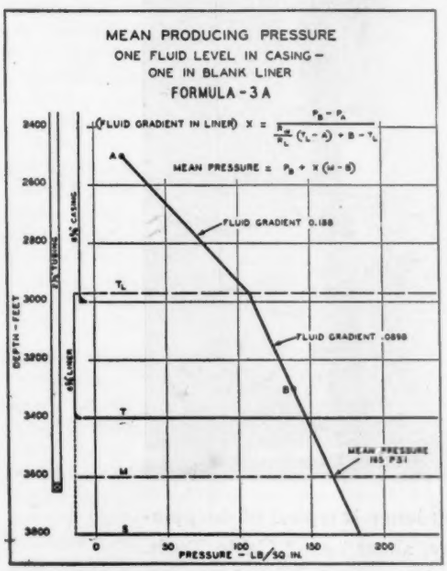
The type of structure concerned is a simple monocline of low uniform dip, closing against a normal fault. The reservoir, with approximately 200 ft. of productive interval at a depth of 2,000 ft. and a closure of about 400 ft., is characterized by active water drive, high permeabilities, and correspondingly large productivity indices. Initial formation pressure has decreased only slightly to its average of about 500 lb. per sq. in. at present. The well spacing approximates 6 acres per well, and an interesting fluid-flow aspect is the fact that the oil is said to exhibit a viscosity 350 times that of water under reservoir conditions.

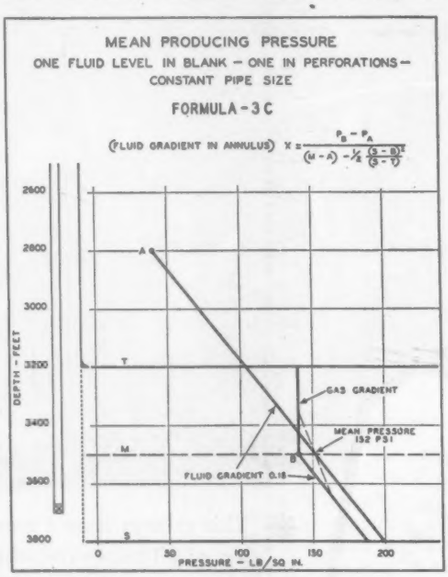
Since investigation and adoption of this method of cut prediction for these fields, the administrator's engineering staff applies to the gross potential the water percentage shown to be normal for this well depending upon its cumulative oil production, or the demonstrated test cut, if higher. Although this method is not exact, it is acceptable to the conservation authority and the operators of the fields in question. . . .

Producing gradients in pumping wells.

A knowledge of fluid gradients is essential to the evaluation of mean-producing and static pressures in pumping-well tests. The term "fluid gradient" is used to designate the pressure gradient along the fluid column. The producing fluid gradient in the annulus above the pump is established by sonic-test procedure, whereas it must be estimated in the case of pump-recorder tests. As the fluid gradient at the potential rate is unknown, it is assumed arbitrarily to be the same as the gradient observed or estimated at the highest demonstrated rate.

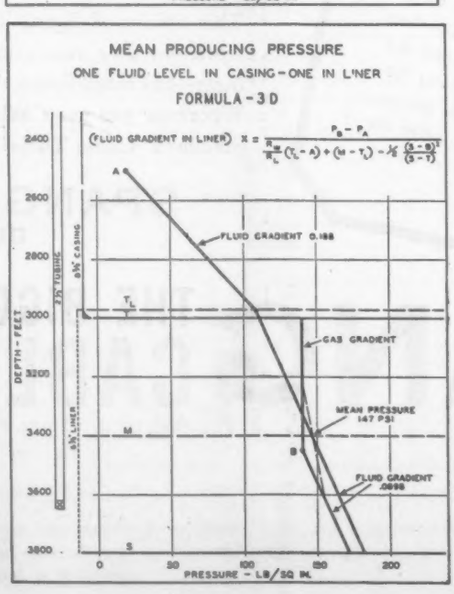
The simple case of fluid-gradient determination by sonic means in a well producing at a constant rate is shown in Fig. 2. This is a case wherein the fluid level is observed at two or more points in blank casing, with uniform annular area between tubing and casing, and the well is completed with perforated pipe of the same diameter

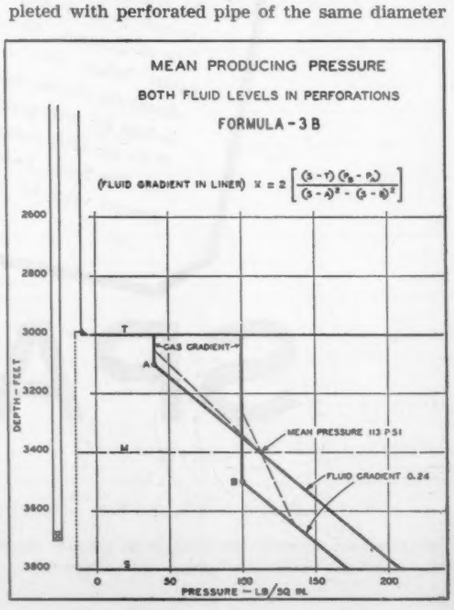

MEAN PRODUCING PRESSURE
ONE FLUID LEVEL IN CASING—ONE IN BLANK LINER
FORMULA - 3 A
FLUID GRADIENT 0.188
FLUID GRADIENT .0898
MEAN PRESSURE 115 PSI
DEPTH - FEET
PRESSURE - LB/SQ IN.


MEAN PRODUCING PRESSURE
ONE FLUID LEVEL IN BLANK — ONE IN PERFORATIONS — CONSTANT PIPE SIZE
FORMULA - 3 C
GAS GRADIENT
MEAN PRESSURE 132 PSI
FLUID GRADIENT 0.18
DEPTH - FEET
PRESSURE - LB/SQ IN.

Symbols for Formulas 3A, 3B, 3C, and 3D: X = fluid gradient in liner, lb. sq. in. A = depth of upper fluid level, ft. B = depth of lower fluid level, ft. P_A = pressure at fluid level A, lb. sq. in. P_B = pressure at fluid level B, lb. sq. in. T = depth to top of productive interval, ft. T_L = depth to top of liner, ft. M = depth to midpoint of productive interval, ft. S = depth to bottom of productive interval, ft. R_W = area of annular space between tubing and water string, sq. in. R_L = area of annular space between tubing and liner, sq. in.

Fig. 6. (above), Fig. 7 (right, above), Fig. 8 (right), Fig. 9 (extreme right)—Examples of mean-producing-pressure determination based on calculated gradient from fluid-level measurements





Does there not seem to be a prophetic quality in the selection, long years ago, of the eagle as the emblem of the Republic — not the static eagle of heraldry but the majestic, courageous and keen-visioned eagle of American mountain tops?

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as the blank section. The gradient is the difference in pressure at the fluid surfaces divided by the distance between the levels. The pressure at the lowest observed fluid level is extrapolated to the bottom of the productive interval on the basis of the measured gradient, and the mean producing pressure is calculated from these values. This procedure involves the assumption that when annular areas are uniform, (1) a linear relation exists between pressure at the fluid surface and depth of fluid level for any stable producing rate, provided operating fluid-level observations are made above the top of perforations; and (2) the fluid gradient in the perforations is the same as that determined in the blank casing. The general applicability of the first assumption to California conditions has been confirmed by numerous multiple fluid-level measurements in various fields and by simultaneous determinations of operating pressures in wells by means of the sonic method and pump recorder. . . . There is a notable lack of data as to the fluid gradient opposite producing sands in pumping wells, and use of the second assumption will have to be continued until this factor can be evaluated. It is to be noted that no correction is made for the change in gradient resulting from the increase in annular area below the bottom of tubing.

TABLE 3—SUCCESSFUL* DETERMINATION OF POTENTIAL BY SONIC FLUID-LEVEL DRAWDOWN METHOD

WELL CONDITIONS

Oil gravity	17.3° A.P.I.
Total cut	50 per cent
Shut-in casing pressure	1 lb. per sq. in.
Approximate ratio of gas to gross fluid	20 cu. ft. per bbl.
Calculated fluid gradient	0.402 lb. per sq. in. per ft.
Observed fluid gradient at rate of 507 bbl. per day	0.400 lb. per sq. in. per ft.
Observed fluid gradient at rate of 175 bbl. per day	0.398 lb. per sq. in. per ft.

TEST RESULTS

	Recorder	Sonic	Difference (per cent)
Mean producing pressure at rate of 508 bbl. per day (lb. per sq. in.)	286	287	0.3
Mean producing pressure at rate of 175 bbl. per day (lb. per sq. in.)	313	316	1.0
Gross productivity index (bbl. per day per lb. per sq. in.)	12.33	11.49	6.8
Calculated potential, gross (bbl. per day)	3,958	3,848	2.8
Calculated potential, net (bbl. per day)	1,980	1,924	2.8
Discounted potential, net (bbl. per day)	476	474	0.1

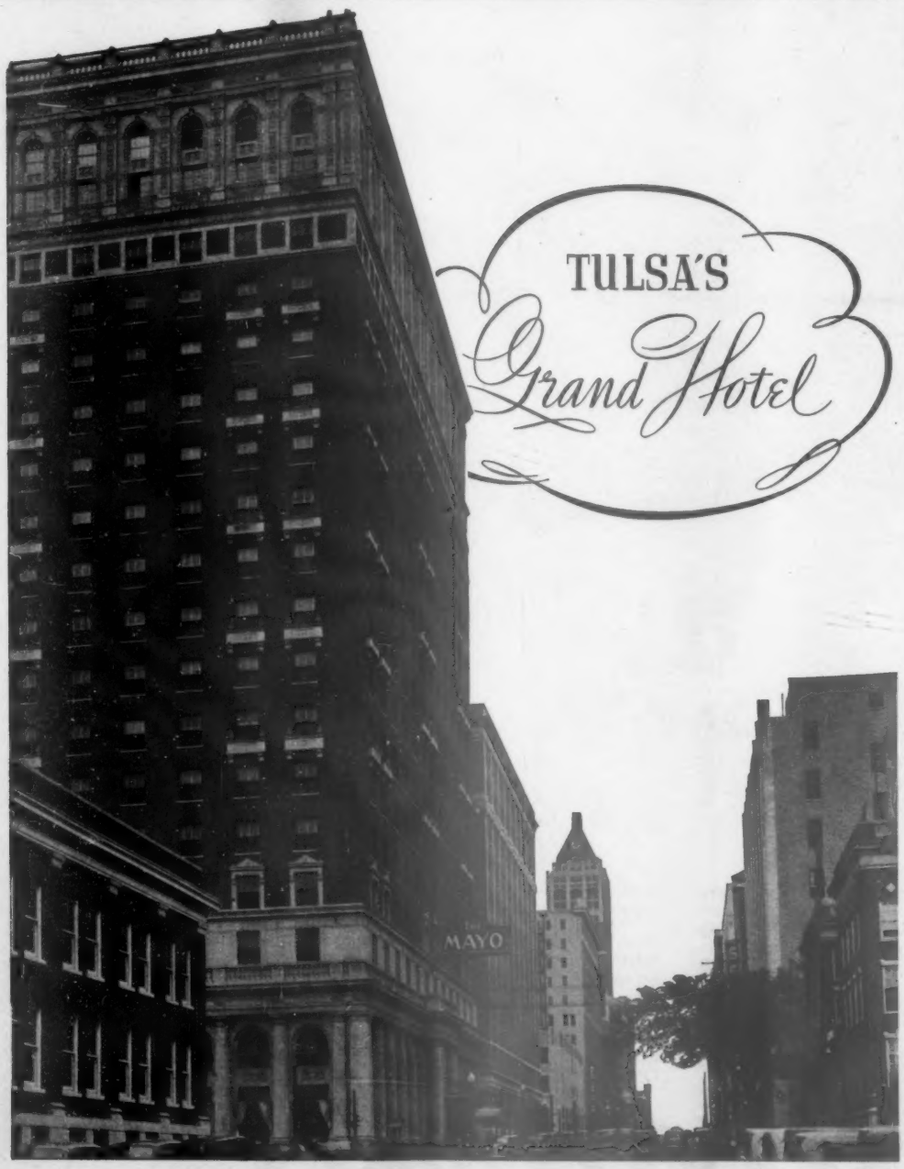
*Two other tests were unsuccessful.

Calculation of fluid gradient becomes less certain at wells in which there are significant changes in annular area in the section occupied by the fluid column. Sonic data collected to date suggest that in many cases the fluid gradient varies directly with the cross-sectional area of the annulus. This convenient empirical relation has been used to adjust fluid gradients for changes in annular area in all sonic and pump-recorder tests. However, more data will have to be obtained and correlated before the relationship can be established definitely. The formula used for calculation of fluid gradient in the liner when fluid levels are measured in blank pipe with two different annular areas is shown in Fig. 6. The adjustment of fluid gradient for change in annular area is made only at wells producing appreciable quantities of gas through the casing. Theoretical considerations and field observations show that the relationship does not apply to wells producing small volumes of casing gas (in the order of 5,000 cu. ft. daily).

Figs. 7, 8, and 9 show the formulas used for calculation of fluid gradient opposite the perforated interval when one or more observations are made in the productive interval and the annular areas involved are uniform or nonuniform. These formulas are based on the assumptions previously discussed and upon the additional one that the specific productivity of the sands is substantially constant. The derivation of these formulas is in print,[8] and is not repeated herein. When the operating fluid level is below the top of the productive interval, the pressure against the portion of the interval exposed to the gas column increases as the fluid is depressed. Wells showing a significant drop in production when the operating fluid level is depressed below the top of the productive zone must be tested by a different procedure.

The pressure at one depth, i.e., the pump inlet, is determined in pump-recorder tests, and an estimated producing gradient is employed in the calculation of mean producing pressure. Gradients, supplied operators by the oil administrator's office, are based on data accumulated by sonic determinations in the field under consideration. Data correlated to date indicate that fluid gradients above the pump are a function of the gravity of the crude, the volume of gas passing up the annulus, and the annular area. The cut does not seem to be of major importance, except in the case of very wet wells producing limited quantities of gas. The method of attack has been to correlate fluid gradient with average annular gas velocity, based on gas volume under atmospheric conditions, for the various fields and zones. An example of this type of correlation is shown in Fig. 10, which is based on sonic measurements of 20 wells in a Los Angeles Basin field. The fluid

(Continued on Page 160)



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QUESTIONS ON TECHNOLOGY

By W. L. NELSON, TECHNICAL EDITOR

W. L. NELSON

This department of The Oil and Gas Journal is devoted to the manufacturing branches of the oil industry.

Those connected with the refining of crude petroleum, the manufacture of natural gasoline and closely allied industries are invited to submit their problems to W. L. Nelson, technical editor. The department was created for the purpose of aiding managers, superintendents, engineers, chemists, and all those engaged in the various phases of plant operation; also those connected with the marketing and utilization of petroleum products.

Questions should be submitted in as much detail as possible. Inquiries must be signed but only the given initials will be printed. The source of the question is considered to be confidential.

Questions requiring a discussion of patents, extended computations, or a detailed study cannot be considered. When the matter is of general interest, a reply will be published within a reasonable time.

Iodine Number of Gasoline

Some time in the past Dr. C. K. Francis outlined a method of procedure for determination of the iodine number of gasoline. Could you advise us concerning this method?—F. A. S.

Our index of Technical Questions does not disclose the method to which you refer. We are suggesting the Hanus method (Z. Nahr Genussen 16, 913, 1901) with modifications as outlined by Dean and Hill in Technical Paper 181, 1917, of the U. S. Bureau of Mines.

Before discussing this method, it should be recalled that bromine numbers are now generally considered to be more accurate and useful than iodine numbers, although there are objections to all of the methods that are being used to determine unsaturated hydrocarbons in gasoline. The main objection to the iodine-number test is the slow rate of reaction of iodine, and to uncertainty as to when the reaction is complete or when substitution reactions begin to take place. The bromine reaction is more rapid and is accurate for olefins and diolefins but its value is questionable when applied to triisobutylenes, terpenes, and certain other ring structures. The bromine-number method is given in Universal Oil Products Laboratory Test Methods for Petroleum and Its Products (1940) published by the Universal Oil Products Co., 310 South Michigan Ave., Chicago.

Technical Paper 181 of the Bureau of Mines in which Dean and Hill describe the Hanus method for iodine number is an old publication (1917) and hence the procedure is given here in full:

Preparation of Solutions

The Hanus iodine solution is made by dissolving 13.2 g. of iodine and 3 c.c. of bromine in a liter of glacial acetic acid. This solution should be allowed to stand several days before using.

Sodium thiosulfate solution is prepared by dissolving approximately 25 g. of the crystallized salt ($Na_2S_2O_35H_2O$) in each liter of water.

Potassium dichromate solution is prepared by dissolving 3.8663 g. of very pure dry salt ($K_2Cr_2O_7$) in water and making up the volume to a liter. This is the basic standard solution for this method and must be prepared and preserved with great care. The quantity taken will liberate 10 g. of iodine from an acidified solution of potassium iodide.

Potassium iodide solution is made by dissolving one part by weight of the pure salt in nine parts of water.

Starch indicator solution may be prepared in various ways. The method of Gooch is highly satisfactory; 5 g. of starch is mixed with a tiny bit (about 0.01 g.) of red mecuric iodide and rubbed to a smooth paste with cold water. This paste is poured into a liter of vigorously boiling water and stirred thoroughly, the boiling being continued for a minute or two. The solution is allowed to cool and settle; the clear portion is decanted into a bottle from which it is used. About 3 c.c. is used in each titration. If red mecuric iodide is not available the solution may be prepared without it, and when cold shaken with a few drops of chloroform, which acts as a preservative.

Standardization of Solutions

Sodium thiosulfate solution is standardized against the potassium dichromate solution as follows: 25 c.c. of the latter, equivalent to 0.25 g. of iodine, is run from a pipette into a 200-c.c. Erlenmeyer flask containing about 12 c.c. of a 10 per cent solution of potassium iodide and 5 c.c. of ordinary concentrated, chemically pure, hydrochloric acid. The iodine thus liberated is titrated with sodium thiosulfate solution, the standard of the latter being recorded in grams of iodine equivalent to each cubic centimeter of the thiosulfate solution. The thiosulfate solution needs to be restandardized occasionally, as it changes slightly on standing.

The Hanus iodine solution is standardized daily in the regular course of making determinations by "running a blank."

Method of Determination

The general scheme of procedure is as follows: Reaction mixtures are made up in the special glass-stoppered Erlenmeyer flasks sold for the purpose by chemical supply houses. The mixtures may be prepared at uniform intervals (5 minutes is a convenient period) until 30 minutes have elapsed, when the first mixture is titrated. One of the factors that insures agreement of results is uniform time of reaction, and the 30-minute period recommended by Smith and Tuttle (Bureau of Standards Tech. Paper 37, 1914) should not be allowed to vary more than 2 or 3 minutes either way. Determinations may be run conveniently in series of six, as each mixture can be made up in a 5-minute period.

The procedure for a single sample is as follows: First, 10 c.c. of chloroform or carbon tetrachloride is measured into one of the glass-stoppered reaction flasks. The proper quantity of gasoline is then measured in, care being taken that there is no loss through evaporation. A convenient method of accomplishing this involves the use of a small capillary pipette made from glass tubing of about 1 mm. internal diameter and marked at intervals along its length. The volume from the pointed tip to each of the marks is determined by weighing the pipette first empty, and then filled with pure distilled water, measured at a temperature of 15°C. Different known quantities of gasoline measured at the same temperature, can therefore be delivered from this instrument. The density of the gasoline should be known, measured for 15/15°C. The quantity used should be such that 10 to 30 per cent of the iodine used is absorbed. It is not always possible to hit on the right ratio between Hanus solution and gasoline at the first trial, but a second determination should always bring the quantities within the proper limits.

The capillary pipette, after being filled with the gasoline (at a temperature of 15°C.), is discharged with its tip held below the surface of the chloroform or carbon tetrachloride in the flask. The empty pipette is then partly washed by filling it once with the diluted gasoline mixture and letting the contents drain out. Washing is completed by filling once with pure solvent (chloroform or carbon tetrachloride) and draining again into the flask. This procedure avoids exposure of a large surface of pure gasoline to the air and reduces evaporation losses to a negligible quantity. In the present work the quantity of Hanus solution used was 10 cc. and the quantities of gasoline between 0.04 and 0.20 gram.

The reaction mixture is allowed to stand for 30 minutes, preferably in the dark and never in direct sunlight. At the end of this time 25 c.c. of potassium iodide solution is poured in and 100 c.c. of distilled water added. The mixture is then titrated with the standardized sodium thiosulphate solution, care being taken to shake the mixture vigorously as soon as the yellow color fades in the aqueous layer. This precaution is to insure the removal of the iodine dissolved in the carbon tetrachloride or chloroform layer at the bottom of the flask. The starch indicator should not be added until after the yellow color of the iodine becomes faint. Warning of the approaching end of the titration is given by the color changing from greenish to blue. The titration is complete when the blue color just fades.

The iodine number is the percentage by weight of iodine absorbed and is calculated by the following procedure: The titer of the unknown mixture is subtracted from that of a blank, consisting of Hanus solution and solvent allowed to stand 30 minutes without any gasoline, and the difference in cubic centimeters of thiosulphate solution is multiplied by the weight of iodine equivalent to each cubic centimeter of the solution. The weight of iodine thus found is divided by the weight of gasoline taken, and the quotient is multiplied by 100, which gives the iodine number.

Determination of Well Potentials In California

(Continued from Page 156)

gradient in this case appears to be inversely proportional to the square of the velocity. Because of the limited number of sonic tests which form the basis of the current correlations and the doubtful reliability of the reported gas production of pumping wells, the present relationships are considered to be rough approximations subject to revision as more data are secured. However, they are useful in that they afford a uniform basis for the estimation of producing gradients for any well.

It is believed that improvement in the technique of interpreting and estimating producing fluid gradients is one of the most important ways by which the accuracy of pumping-well potential calculations can be improved. The problem should continue to receive the full attention of operators, the oil administrator's staff, and the depth-pressure advisory committee. . . .

Summary

In addition to the benefits rendered the statewide proration system in the direction of improved accuracy, more equitable relative well ratings, and decreased physical hazards to wells and reservoirs, the engineering approach discussed herein accelerates the investigation and solution of related problems. The value of its incidental well-performance information is unquestionable, and the widespread adoption of subsurface-pressure methods is encouraged.

Meetings of the advisory committee serve as an informal forum for interchange of ideas covering equipment, procedure, and new development generally, among the steadily widening group. Criticism of the method and its economic value is concerned primarily with the cost, inconvenience of complying with fixed rules, and diminishing financial return, rather than against the fundamental concepts. The engineering aspects receive constant attention, and steady progress results from elimination of unsuccessful approaches as well as from confirmation of sound methods.

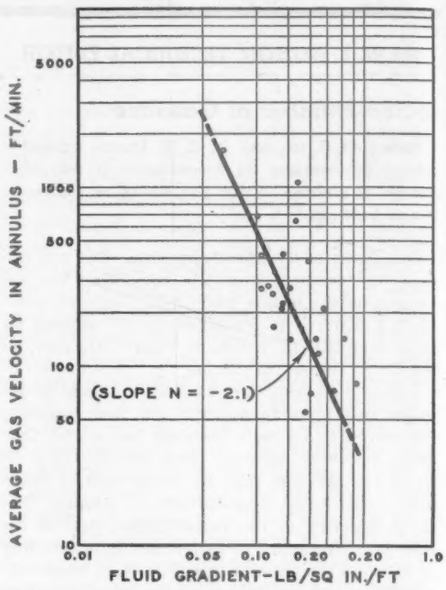

Fig. 10—Curve relating fluid gradient and average gas velocity in annular space between tubing and casing of pumping well. Data obtained from wells in the same field and zone

The comprehensive background of carefully compiled data gathered from most fields in the state in connection with the depth-pressure-potential method should prove valuable if it is systematically reviewed, correctly analyzed, and properly applied.

Acknowledgment

Acknowledgment is made to the many operators, service companies, and engineers who have cooperated in furnishing much of the data included in the paper. William R. Wardner, Jr., assistant oil administrator; D. L. Caldwell, Barnsdall Oil Co.; and E. V. Watts, General Petroleum Corp., have contributed materially; and the authors wish to express appreciation for their helpful criticisms and suggestions.

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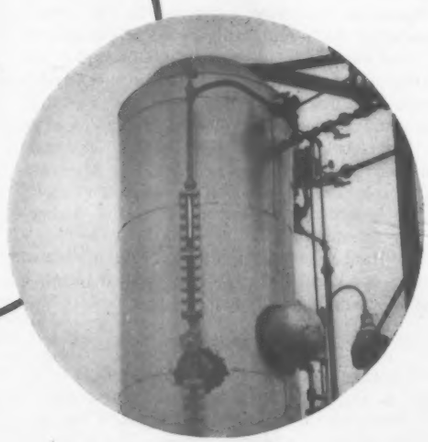

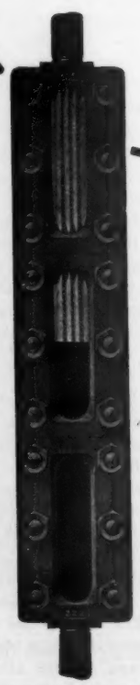

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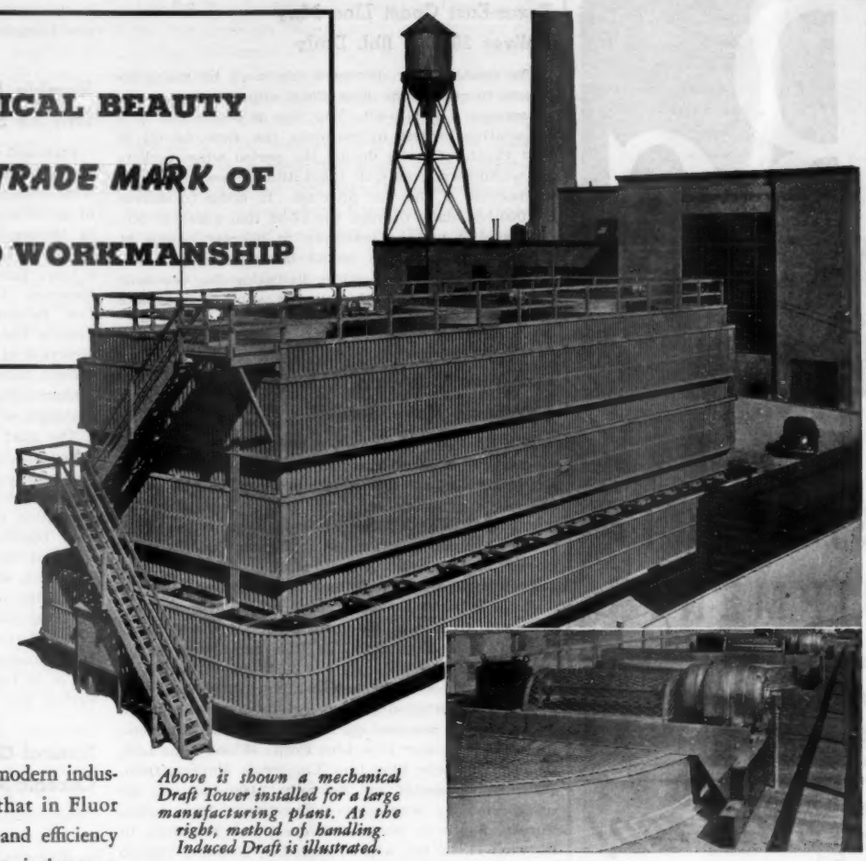

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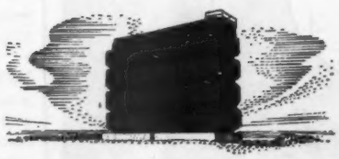

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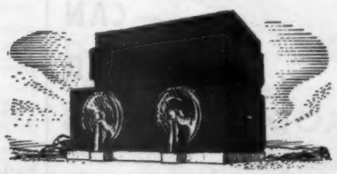

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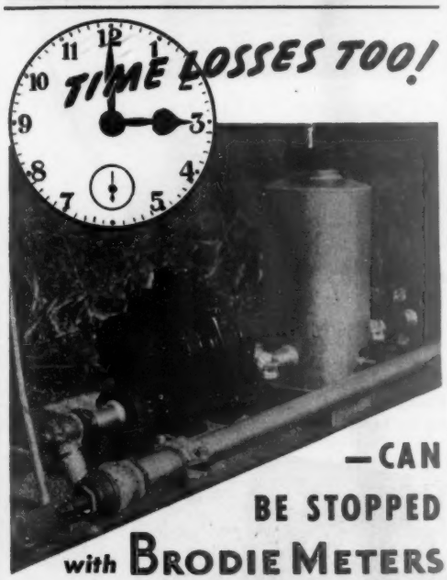

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Pipe-Line Activity

Texas-East Coast Line May Deliver 300,000 Bbl. Daily

The crude-oil line discussed this week by major interests to relieve the East Coast situation will break all records if it is built. This line is considered as a cooperative project to maintain the flow of oil to East Coast refineries during the period when tankers are withdrawn from Gulf Coast-Atlantic seaboard service because of the war program. In order to deliver 300,000 bbl. daily through the 24-in. line which is contemplated it will be necessary to operate pumps at 600-lb. pressure which would be installed at intervals of 50 miles. An article discussing the economic and legal features of this project appears elsewhere in this issue.

East Texas-Bayway, N. J., Crude Shipments Have Started

The first step has been taken to counteract the diversion of tankers from the Gulf Coast-Atlantic seaboard service as the result of war requirements. Shipments of crude oil from East Texas points by Standard Oil Co. of New Jersey interests for delivery at the company's refineries at Bayway, N. J., commenced May 13, when a tariff of 67½ cents per barrel was authorized by the Interstate Commerce Commission. This tariff covers transportation over the entire route from Arp, Bateman, Gladewater, and Longview, Tex., to Bayway, N. J. It is expected that the first oil in these shipments will begin to arrive at destination in the first half of July. Pipe lines used in this transportation hookup include those of Humble Pipe Line Co., Standard Oil Co. of Louisiana, Oklahoma Pipe Line Co., Ajax Pipe Line Corp., Illinois Pipe Line Co., and Buckeye Pipe Line Co. From Mantua, Ohio, eastward shipments will be split; 7,000 bbl. will be transported by Southwest Pennsylvania Pipe Lines, Eureka, Southern, National Transit and Tuscarora to Bayway; 11,000 bbl. will be moved by National Transit to Millway, Pa., where it will be taken by Tuscarora for delivery at Bayway. The route to be followed by the remainder of the oil in these shipments has not been determined. Shipments from East Texas points will amount to about 20,000 bbl. per day. In addition, oil will be moved over this pipe-line hookup from North Louisiana and southern Arkansas.

At the beginning of this week it is reported that oil in these shipments had arrived at the Standard of Louisiana's terminal at De Queen, Ark. Between this point and Glenpool, Okla., these shipments will use the full capacity of Oklahoma Pipe Line Co.'s 8-in. trunk line. From Glenpool to Wood River, Ill., these shipments will move through the Ajax Pipe Line Corp. system which consists of two 10-in. lines having total daily capacity of 65,000 bbl.

The Ajax system will continue to transport shipments of crude for Gulf Refining Co. which have been in progress since last December. These shipments start at Glenpool and are transported to Marcus Hook, Pa., through a pipe-line hookup which includes some of the facilities which have been assigned to handling the East Texas-Bayway, N. J., shipments. A rate of 57 cents per barrel was authorized for the Glenpool, Okla.-Marcus Hook, Pa., shipments have been scheduled for delivery at the rate of 10,000 bbl. per day. (The Oil and Gas Journal, Dec. 12, 1940, p. 65; Jan. 2, 1941, p. 53.)

Oklahoma Pipe Line Adds Pumping Equipment at Council Hill, Okla.

Preliminary arrangements have been made for the installation of electric-driven centrifugal-pump equipment at the Council Hill station of the Oklahoma Pipe Line Co.'s trunk line from southeastern Oklahoma to Glenpool, Okla. This booster equipment will make it possible to increase deliveries through the system which is now scheduled to move 20,000 bbl. per day from East Texas to Bayway, N. J. The program of Standard Oil Co. of New Jersey is reported to call for deliveries of 24,000 bbl. per day including Arkansas and Louisiana oil as well as East Texas oil.

Humble Plans Portland-Montreal Line for Standard of New Jersey

Standard Oil Co. of New Jersey is having Humble Pipe Line Co. handle the engineering work connected with project under consideration for the construction of a 250-mile 12-in. crude-oil line from Portland, Me., to Montreal, Que. This line would have a capacity of 50,000 bbl. per day and would serve in supplying a large part of the requirements of five refineries in Montreal: Imperial Oil, Ltd., McColl-Frontenac Oil Co., Ltd., British American Oil Co., Ltd., Shell Oil Co. of Canada, Ltd., and Champlin Oil Products Co., Ltd. Construction of this line would eliminate the long haul around Nova Scotia which would probably release five tankers. Pipe for the project has been ordered by Standard of New Jersey interests.

The staff of Humble Pipe Line Co., which is engaged in the engineering and preliminary arrangements, is carrying on this work at Portland. Two of the men assigned to the project by the Humble organization are Harry D. Dickson, division civil engineer, Humble Oil & Refining Co., and George A. Lee, assistant division superintendent, Humble Pipe Line Co., both of Midland, Tex. Mr. Dickson expects to be on the job for 2 or 3 months while Mr. Lee will probably remain for 6 months.

The Portland-Montreal project is one of the several being studied by oil interests as a result of the transfer of 25 United States registry tankers for use in the British war effort.

Natural Gas Pipeline Shuts Down Osceola-Muscatine, Iowa, Project

Natural Gas Pipeline Co. of America shut down work on the section known as No. 6. This has been due to difficulty in obtaining pipe for 83 miles of 26-in. from Osceola to Muscatine, Iowa, at the Mississippi River. A contract for this section of the line was let in the early part of April to W. A. Bechtel Co. Pipe deliveries are being made and work is going forward on the 101 miles of 26-in. pipe which has been contracted by O. E. Dempsey Construction Co.; this extends eastward from Crescent, Iowa. Work has been in progress on two other contracts: C. S. Foreman Co., with headquarters at Saline, Kans., has been laying line for a 98-mile section extending eastward from Wilson, Kans.; W. A. Bechtel Co. has been laying a 121-mile section extending northwestward from the Borger, Tex., area.

Stanolind Furnishes Outlet at Cedar Lake Pool, Texas

The Cedar Lake pool of Gaines County, Texas, opened 2 years ago by Stanolind Oil & Gas Co., will be given a pipe-line outlet by that firm. It will be a 4½-mile 4-in. line from the field to a point connecting with the Texas-New Mexico Pipe Line Co.'s carrier which runs through western Dawson County from the Slaughter field to the town of Midland. The oil will be carried through the trunk carrier for delivery to the Atlantic Refining Co. at the Midland terminal. This is the first outlet for the field, oil previously having been trucked to the Basin Pipe Line Co.'s station in the Wasson field where it entered that line and thus to the Cosden refinery at Big Spring, Tex. Under the new system the oil will enter Atlantic's line at Midland for transportation through its 10-in. line to Port Arthur on the gulf.

Anchor Hocking Issues Specifications For 85-Mile Natural-Gas Pipe Line

Anchor Hocking Glass Corp. has issued specifications for a natural-gas pipe line from the Ravenswood gas field near Sandyville, W. Va., to its two glassware

Pipe-Line Personalities . . . . F. E. Richardson

FRANK E. RICHARDSON, until recently chief engineer of the Great Lakes Pipe Line Co., Kansas City, Mo., has resigned that position and joined the Pan American companies in Houston, Tex., as manager of the Pan American Pipe Line Co., and assistant manager of Pan American Production Co. and Pan American Gas Co. In these capacities he will function as operating and administrative assistant to E. R. Turner, vice president of the three companies.

Mr. Richardson was born in Mahoney City, Pa., and was educated for mining engineering at Ohio Wesleyan University. After graduation, he spent 4 years as a consulting engineer at Clarksburg, W. Va., doing mining, municipal and oil-field engineering. From 1916 to 1922, he designed and constructed gasoline plants throughout the Mid-Continent field, and from 1922 to 1923 was assistant superintendent and designing engineer on the construction of the Spavinaw Dam in northeastern Oklahoma, which was built for the purpose of furnishing Tulsa with a municipal water supply. After the completion of this work, he went to Wyoming and was general superintendent of construction and operation of the refinery and town of Parco, Wyo. From 1926 to 1929, he was chief engineer and assistant production manager for the Marland and Continental Oil companies in Texas and Oklahoma, devoting his main efforts toward design, installation and operating efficiency of plants and equipment having to do with the production of crude oil and gas.

When the Great Lakes Pipe Line Co. was organized for the purpose of constructing their gasoline lines from Oklahoma to the north central states, he joined that company as chief engineer for design, construction and operation of the system, and since that time has served as chief engineer.

Mr. Richardson is a member of the American Society of Civil Engineers and Sigma Alpha Epsilon Fraternity. He is married and he and Mrs. Richardson will make their home in Houston.

manufacturing plants at Lancaster, Ohio. The line is to be 12½ in. in diameter; the length will be slightly more than 85 miles. Bids will be received June 2 at the company's office at Lancaster and a contract will be let within a few days. Engineering and inspection of the line is in charge of Midwestern Engineering & Construction Co. The line will cost nearly $1,000,000 and it has been estimated that it will save the company $3,794,430 in natural-gas costs over a 9-year period.

Mountain Fuel Supply Plans Gas Line in Wyoming

Mountain Fuel Supply Co. is planning to lay 32 miles of 8⅝-in. o.d. pipe for a natural-gas line which will loop part of the company's system. The line will start at a point 65 miles southeast of the Rock Springs, Wyoming, field. Specifications will be issued and bids will be received in September and it is expected that work will start early that month.

Illinois Will Continue to Move West Central Texas Oil

Illinois Pipe Line Co. will continue to carry crude from the West Central Texas counties, which it serves, to the Fort Worth refinery of the Ohio Oil Co. for an indefinite period, according to a recent announcement. The Ohio company previously had announced that it would discontinue purchases in the area on May 10.

Some 500 wells, chiefly strippers, are served by the pipe line in Stephens, Eastland, Palo Pinto and Erath counties. This involves 275 miles of gathering system. The purchases from the wells amount to around 3,500 bbl. daily, or 100,000 bbl. per month.

W. R. Davis, Inc., Buys Valley Pipe Line Co.

HOUSTON, Tex.—W. R. Davis, Inc., of Houston, Tex., has purchased all of the stock of the Valley Pipe Line Co.

The Valley Pipe Line Co. has a 5-in. line running from the Rincon field, Starr County, Texas, to Brownsville and Port Isabel, Tex. The Davis company announced it would take up this line and lay a new 100-mile 8-in. line to its terminal at Brownsville. The Valley Pipe Line Co. also serves as a carrier for several other Rio Grande Valley pools. An additional pumping station will be built to serve the new line.

W. R. Davis announced the Rincon Pipe Line Co., a gathering system at Rincon, and the Brownsville Terminal Co. will be incorporated with the Valley Pipe Line Co. later.

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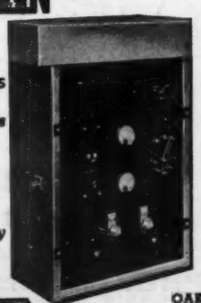

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REPUBLIC

FIELD DEVELOPMENTS...

HIGHLIGHTS FROM THE WEEK'S NEWS—

Completions dropped 19 wells during the past week to a total of 558. There were 27 more oil wells but 13 fewer gas wells and 33 fewer dry holes.

Developments in the different fields were overshadowed by price increases in Illinois, Oklahoma, Kansas and the Texas Panhandle. During the past 5 months, refinery runs have stood at a level considerably above those of last year, while crude production is now nearly 18,000,000 bbl. below last year's level. There has also been a slight increase in crude storage. With the transfer of tankers to the British, imports should be reduced as well as shipments from the Gulf to Atlantic ports. This trend will benefit the areas where prices have risen.

In Illinois, production appears to be about static as new wells just offset the normal decline. There is little in sight to justify a belief that Oklahoma will increase its production. This leaves Kansas and the Texas Panhandle to make up most of the deficiency. Kansas has a large number of proven locations to drill, but there are many more in the Panhandle. Already, in anticipation of better times, an abnormally high number of locations are being staked. This may develop into a real boom in the near future.

ILLINOIS: Louden's long-awaited Devonian test swabbed and flowed 35 bbl. an hour with about 10 bbl. of water. The source of the water is not known as it may be coming from a higher formation. If it proves to be from the Devonian, it will provide a damper for the field. The same operators, Jarvis Brothers, drilling their second Devonian test picked up a fifth pay for the field, the Rosiclare. The sand is being tested. Jackson County has its first field during the present play in the Benoist. The old Ava-Campbell pool, abandoned in 1934, produced from the Cypress. It was about 22 miles west of the present discovery. McClosky production in Richland County and White County reports its almost-weekly discovery (p. 185).

APPALACHIAN: The five tests now drilling in the Onondaga in Southwest Pennsylvania and West Virginia, are expected to increase the Oriskany gas production of that area. A sixth test, now in the Oriskany, is reported to be picking up additional gas (p. 174).

OKLAHOMA: A test running low in the Wilcox at Guthrie may open up Misener production for the pool. A Viola lime pool has been opened at about midway between West Earlsboro and the Tecumseh Lake pool (p. 175).

KANSAS: Silica was extended 1 mile north and Big Creek ½ mile southeast. Further development in these directions will reach other pools soon, continuing the Kansas practice of making big ones out of little ones (p. 178).

WYOMING: Activity is largely directed toward the heavy-oil fields and gas areas as drilling at Lance Creek is nearing completion. The Tensleep sand is providing good producers (p. 168).

EASTERN TEXAS: Another Woodbine sand wildcat shows promise as Hickok & Reynolds' test, near Canton, Van Zandt County, checks 171 ft. above a dry hole only 2 miles away. Chapel Hill is extended ½ mile south in the Pettit (p. 193).

LOUISIANA GULF COAST: Flank production was found around another old salt dome as Union Sulphur picked up production in the Marginulina at Welsh at 6,535 ft. An east outpost to Erath is reported flowing and the operators are reported to be moving 1 mile southwest of the discovery. After production had been obtained from seven sands below 7,000 ft. on the highly faulted West Lake Verret structure, Shell opened up a 2,350-ft. sand with a 75-bbl. flowing well (p. 167).

OHIO: Ohio Oil Co. appears to specialize in showing other operators how to find oil in the St. Peter. After picking it up in Erie County, Pennsylvania, the company moved 120 miles to the southwest and found another showing just east of the old Clinton gas field near Wooster in Wayne County (p. 187).

WEST CENTRAL TEXAS: Gas fields were opened by good wells in Coleman and Eastland counties. A shallow pool has been opened in Callahan County near the Shackelford County line by Clark & Young at 430 ft. Brannon & Murray's well near Talpa in Coleman County was improved on acidization and it is planned to give it another shot (p. 176).

NORTH TEXAS: Gulf has picked up Ellenburger production in the old Worsham field in Clay County at 5,700 ft. Ellenburger production from K.M.A. should increase materially during the summer as almost four times as many wells are under way as now produce from that formation (p. 176).

WEST TEXAS: Deep exploration is gradually extending over the whole basin. The latest start is in eastern Upton County not far from Big Lake, the first Ordovician pool in the area. There were 21 wells completed in Slaughter and Wasson, with a possible mile east extension for the former field (p. 182).

ARKANSAS: A wildcat 5 miles east of Dorcheat and on what may prove to be the same structure has oil showings in the Cotton Valley formation, well above the Smackover lime which produces at Dorcheat. The Crescent test 3 miles east of Schuler is at the top of the Jones sand (p. 188).

TEXAS GULF COAST: After a search of some 8 years, Cockfield oil has been found on the Garwood structure, Colorado County. Tests at Halls Bayou and West Conroe, formerly thought favorable, are not showing up so well. The former shows salt water and the latter dry gas (p. 171).

CALIFORNIA: Western Gulf has showings in a sand, believed to be in the lower Modelo in Oak Canyon. The test which may finally bring in the farthest north field has passed up the Santa Margarita pay and is now around 6,000 ft. or 1,200 ft. below the show to give the structure a thorough test (p. 166).

SOUTHWEST TEXAS: An attempted blowout at 8,043 ft. in the La Gloria field promises a deeper productive sand (p. 172).

MICHIGAN: Completion of the biggest well to date in the Winterfield pool has caused an increase in bids for leases on neighboring state land (p. 170).

COMPLETIONS IN ALL FIELDS . . .

(Week Ended May 17, 1941)

	Oil	Gas	Dry	Total	1941 total comp. to date*	1940 total comp. to date*
N. Y., Pa., and W. Va.	97	14	2	113	1,919	1,866
Ohio	2	9	22	33	553	446
Indiana	3	0	5	8	164	127
Kentucky	2	0	7	9	234	170
Illinois	47	0	9	56	1,159	1,219
Michigan	8	2	7	17	321	463
Kansas	52	0	7	59	676	586
Oklahoma	14	0	4	18	535	656
Nebraska	0	0	0	0	31	1
Missouri, Iowa	0	0	1	1	6	11
Texas:						
North Central Texas	36	2	6	44	986	1,212
West Texas	41	0	3	44	730	835
East Texas	26	1	5	32	436	254
Texas Panhandle	13	0	1	14	187	231
Texas Gulf Coast	17	0	1	18	402	487
Southwest Texas	16	1	10	27	673	801
Total Texas	149	4	26	179	3,414	3,820
North Louisiana	10	1	0	11	213	223
Louisiana Gulf Coast	8	2	4	14	304	382
Total Louisiana	18	3	4	25	517	605
Arkansas	1	0	1	2	58	72
Mississippi and Southeast	3	0	5	8	91	77
Montana	2	0	0	2	85	59
Wyoming	2	0	2	4	51	57
Colorado, Utah	0	0	0	0	14	6
New Mexico	5	0	0	5	105	303
California	16	2	1	19	385	431
Total United States	421	34	103	558	10,318	10,999
Total previous week	394	47	136	577		
Week ended May 18, 1940	405	43	146	594		

*Revised.

Producers Seek Restoration Of Heavy-Crude Prices

By
L. P. STOCKMAN

LOS ANGELES, Calif., May 19.—The four associations of California oil producers are making a concerted drive to induce marketing companies to restore prices that existed at the beginning of 1940 and increase heavy crude-oil prices to a level that will permit operators to show a moderate profit. The Oil Producers Agency of California has made a check of production costs and finds that producers of heavy crude are showing a loss of from 10.5 to 34.2 cents per barrel at present posted prices for crude oil. The San Joaquin Valley Oil Producers Association, California Stripper Well Association, and Independent Oil Producers Agency are all endeavoring to secure a revision of the crude structure which appears well out of line and are sympathetic with the suggestion that refined-oil prices should be brought to the point where marketers would not be obliged to sustain refining losses.

AVERAGE DAILY PRODUCTION

LEADING CALIFORNIA FIELDS

	May 17	May 10
Wilmington	84,200	84,250
Midway-Sunset	51,675	54,525
Long Beach	42,225	41,750
Kettleman North Dome	40,400	37,325
Coalinga	38,575	37,925
Ventura Avenue	33,800	32,750
Huntington Beach	29,475	28,850
Santa Fe Springs	23,625	23,650
Dominguez	21,660	21,025
Santa Maria Valley	19,280	19,050

SAN JOAQUIN VALLEY

The most important factor confronting San Joaquin Valley operators from a conservation standpoint is the necessity of producing the type of crude oil that is in good demand, i.e., the heavier grades of crude. In addition to meeting this demand, it would reduce production of light refining grades and in doing so eliminate uneconomic production of oil and gas. Operators in the Paloma distillate field of Kern County are working on and making excellent progress on a plan that will permit this field to produce without selling or wasting any of the natural gas that is produced with the distillate and thus this field will be efficiently operated and waste prevented.

Some operators and landowners interested in this field apparently are not aware of the fact that there is a bill pending in the California Legislature to change operation of the gas-conservation law to facilitate application and make it more effective. Even in its present state this measure is a powerful deterrent to gas waste and will prevent development of the Paloma field unless some method of reinjecting the gas back into the reservoir is devised. Obviously individual operators will not be able to do this because of the high cost involved but will be able to operate successfully through the proposed association which will unify production activities. Some minor changes may be made in the present agreement but these will not affect operation or the effectiveness of the program which is equitable and the only sensible plan for development of a distillate field of this nature.

It is interesting to note that development of this field will eclipse all previous work of this nature due to the extensive amount of acreage considered proved up. It should be remembered also that the eastern limits of production are still undefined and that in view of this condition the productive acreage may later be greatly increased. A total of 5,898 acres is considered definitely proved at the present time. Because of the gas-waste law it will be impossible for individual operators to produce this field because in addition to the interests of all other operators in the common pool, the general public and the state have invested interests in one form or another. No difficulty is expected in getting unanimous approval of operators and landowners.

Raisin City

Shell Oil Co. appears to have the makings of a new oil and gas field in the Raisin City district of Fresno County although it may be some time before this has been definitely determined. Even though the present well fails to result in commercial production it has snowed enough to justify the expectation that a commercial accumulation is located in close proximity. Shell's Raisin City wildcat is located in 18-15s-18e, about 20 miles west and a little south of Fresno and about 25 miles northeast of the Coalinga field. The most remarkable thing in connection with this apparent discovery is the comparatively shallow depth at which the Santa Margarita was found.

In the Buena Vista Hills section of the Midway-Sunset field of Kern County, Honolulu Oil Corp. has passed a depth of 13,800 ft. in its No. 25-P but is not believed to have found the Vedder zone to date. This deep well is at present in a hard tight siltstone with little porosity or permeability and nothing can be expected until the bit gets out of this unfavorable formation. Deep drilling was expected when the well was started but it had not been expected that the section below the Stevens would prove so thick.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: San Joaquin Valley	4	4,234	25,611
Coastal district	5	3,303	32,088
Los Angeles Basin	7	1,316	28,364
Recomp.: Los Angeles Basin	4	1,042	.....
Gas wells: Rio Vista gas field	2	.....	8,509
Dry holes: Wildcats	1	.....	1,707
Total	19	.....	96,279

SAN JOAQUIN VALLEY COMPLETIONS

Elk Hills, Kern County: Standard 27-19-S fee, 19-30s-24e, pumped 440 bbl., 23.8-gravity, 0.5 per cent cut, 75,000 cu. ft. gas, T.D. 4,056 ft., completed in Pliocene oil sand.

Jasmine district, Kern County: White River Expl. Co. 2 Salca, 8-25s-28e, dry in granite at 1,707 ft., top of granite 1,701 ft., no casing landed, no showings from top to bottom.

Mount Poso, Kern County: General Pet. Corp. 6 Heisen, 16-27s-28e, pumped 95 bbl., 15.1-gravity, 10 per cent cut, T.D. 1,780 ft., perf. 1,722-77 ft., completed in Vedder oil zone 1,722-80 ft., bottomed in oil sand.

Rio Bravo, Kern County: Superior 1-3 Osborne, 28-28s-25e, flowed 1,615 bbl., 39.1-gravity, 1.5 per cent cut, 1,830,000 cu. ft. gas, 32/64-in. bean, pressures 1,050/1,300 lb., T.D. 11,440 ft., P.B. 11,385 ft., 120-mesh perf. 11,176-11,385 ft., completed in Rio Bravo and Vedder zones, bottomed in siltstone but P.B. to bottom of Vedder zone.

Rio Vista, Solano County: Amerada 1 Kuhn Comm., 8-3n-3e, flowed 10,000,000 cu. ft. gas, 64/64-in. bean, pressures 1,900/1,900 lb., T.D. 4,300 ft., perf. shot forty ½-in. holes 4,215-35 ft., completed in Cretaceous zone gas sand, green sand 4,097 ft., white sand 4,210 ft., located on Twitchell Island, production est. as no actual gage made.

Amerada 1 Wilcox, 31-4n-3e, flowed 12,000,000 cu. ft. gas, 64/64-in. bean, pressures 2,000/3,000 lb., T.D. 4,209 ft., perf. shot ten ½-in. holes 4,185-90 ft., completed in Cretaceous gas sand, production estimated as no actual gage made.

Ten Section field, Kern County: Shell 5-29-A Kern County Land, 29-30s-26e, flowed 2,084 bbl., 34.6-gravity, 3.2 per cent cut, 3,065,000 cu. ft. gas, 60/64-in. bean, pressures 500/750 lb., T.D. 8,390 ft., perf. 7,970-8,386 ft., completed in Stevens oil sand of Miocene age.

SAN JOAQUIN VALLEY OUTPOSTS

Belridge, Kern County: Sentinel Oil Co. 1 Belridge, 10-28s-20e, drilling 1,668 ft. in sand and shale, elev. 731 ft.

Elk Hills, Kern County: Standard 42-31-S fee, 31-30s-24e, T.D. 8,021 ft. in shale, fishing drill pipe, elev. 1,122 ft.

Standard 45-19-S, fee, 19-30s-24e, drilling 7,110 ft. in sand and shale, elev. 707 ft.

Kettleman North Dome, Kings County: Standard 1-1-U fee, 1-23s-16e, drilling in hard tight sand 12,181 ft., formation test of Eocene 10,860 ft. with packer 10,762 ft., light blow gas with water, elev. 693 ft.

Midway-Sunset, Kern County: North American Oil Consolidated 1-28 W.P., 28-32s-23e, drilling 7,471 ft. in very hard shale with streaks of impervious sand, elev. 1,560 ft.

SAN JOAQUIN VALLEY WILDCATS

Buena Vista Hills district, Kern County: Honolulu 25-P fee, 10-32s-24e, drilling 13,860 ft. in shale with streaks of hard siltstone showing strong gas characteristics, objective is Rio Bravo and Vedder zones, elev. 916 ft.

Buttonwillow district, Kern County: Texas 47-15 Southern Pacific, 15-29s-24e, T.D. 10,728 ft., drilling in sand and shale, elev. 287 ft.

Superior 13 Kern County Land, 18-29s-25e, rigging up and preparing to spud, elev. 313 ft.

Bellevue district, Kern County: Ohio Oil Co. 1-G Kern County Land, 36-29s-26e, drilling 6,311 ft. in sand and shale, temporarily idle account washed out, 13 ft. of Chanac oil sand 5,177 ft., formation test showed good gas blow, recovered 3,900 ft. salt water.

Union 31-3 Kern County Land, 3-30s-26e, drilling 11,060 ft. in sand and shale, Stevens oil zone absent.

Famosa district, Kern County: C. C. M. O. Co. 12-1 Famosa, 12-27s-26e, location staked, General Pet. Corp. and Richfield will contribute some dry-hole money as test will affect their adjacent leases.

Kreyenhagen Hills district, Kings County: S. F. Easterbrooks 1 Kreyenhagen, 11-23s-16e, drilling 668 ft. in surface sand, elev. 1,825 ft.

Lafayette district, Contra Costa County: Lafayette Oil Co. 1 Morris, 28-1n-2w, drilling 792 ft. in sandy shale.

Lost Hills district, Kern County: Associated 46-16 fee, 16-27s-21e, derrick erected, located 1,650 ft. N, 2,310 ft. E from SW cor. 16-27s-21e.

Maricopa district, Kern County, Bankline Oil Co. 24-24 Sunset, 24-11n-23e, drilling and coring in gray siltstone 4,345 ft., top Etchegoin 2,960 ft., elev. 970 ft.

Pyramid Hills district, Kings County: Associated 76 West Slope, 20-24s-18e, drilling and coring in hard Cretaceous shale 3,195 ft., top Cretaceous 2,375 ft., Eocene missing, 13⅜-in. surface pipe 129 ft.

Pyramid Prod. Co. 2 Spreckles, 16-24s-18e, rigging up rotary-drilling equipment.

Raisin City district, Fresno County: Shell 8-18 Properties, Inc., 18-15s-18e, drilling 5,930 ft. in sandy shale, cored oil sand 4,697-4,740 ft., formation test showed gas blow 10 min., recovered 1,000 ft. oil and gas-cut mud, elev. 204 ft.

Rio Vista district, Sacramento County: Amerada 1 Rannpone, 31-4n-3e, drilling in surface sand 798 ft., elev. 20 ft.

Standard 1 Oulton, 9-3n-3e, location staked, elev. 9 ft., Solano County.

Sacramento district, Sacramento County: Portable Drlg. & Equip. Co. 1 Sacramento, 35-8n-4e, drilling 241 ft. in surface sand.

Shafter district, Kern County: Continental 2-G Kern County Land, 35-27s-24e, T.D. 11,349 ft., redrilling 11,118 ft., elev. 986 ft.

Terra Bella district, Tulare County: G. W. Stout 1 Terra Bella, 35-22s-27e, drilling 761 ft., elev. 478 ft., other tests indicate granite should be found at comparatively shallow depth.

Tejon district, Kern County: Continental 1-A Tejon, 28-11n-19e, drilling 4,863 ft. in sand and shale, 11¾-in. surface pipe 503 ft., elev. 874 ft.

Kern Line Oil Co. 1 Tejon, 19-11n-19e, T.D. 8,390 ft., rebuilt rig, rigged up, elev. 970 ft.

Vernalis district, San Joaquin County: Standard 2 Blewett Comm., 25-3s-6e, drilling in shale 5,178 ft., formation test 4,828-58 ft. showed muddy salt water, formation test 3,960-4,007 ft. flowed 6,848,000 cu. ft. gas, elev. 62 ft., gas zone is in Cretaceous.

LOS ANGELES BASIN

In the extreme southern part of the Inglewood structure, Standard Oil Co. has plugged back 3-1 Los Angeles Investment from 10,998 ft. to 8,924 ft. and will attempt to complete the well in the Sentous zone. On a test early this week the well started to flow after the 7-in. casing had been perforated at 8,583-8,700 ft. but the 7-in. casing proved bad above 1,000 ft. and the company subsequently ran in and cemented 1,175 ft. of 5½-in. casing. Before being killed to permit the crew to undertake this remedial work, the well was flowing about 15 bbl. of 38.9-gravity oil with considerable mud and 1,149,000 cu. ft. of gas through a 64/64-in. bean. This well is an offset to 1 Sentous of R. R. Bush Oil Co., the original deep-zone discovery well in the field.

Dominguez

Operators holding acreage east of Main Street in the Dominguez field of Los Angeles County are rapidly proceeding with development work and within the next week or 10 days the erection of several additional derricks is expected. No. 1 Grant, the extension well in the west end of the Dominguez field, is holding up in good shape, present production being 810 bbl. daily of 31.1-gravity oil cutting 0.4 per cent. This well is producing from the seventh Callender zone and this horizon will probably be the objective of other wells during the early stages of work in order not to lose too much time.

There is a possibility that the eighth Callender zone may be found productive south of present work and along the nose of the structure. Unless the eighth Callender zone or a much greater thickness of the seventh

Callender zone is found this work may not prove very profitable if adequately offset by Union Oil Co. The latter will not offset each well west of its Austin lease and thus by drainage the ultimate production of these probable edge wells may exceed the 25,000 bbl. per acre originally expected to be produced during productive life of the wells.

LOS ANGELES BASIN COMPLETIONS

Coyote East, Orange County: Bartholomae Oil Corp. 5-A Stern, 22-3s-10w, pumped 220 bbl., 25.7-gravity, 5 per cent cut, T.D. 6,944 ft., perf. 6,381-6,713 ft., completed in Stern zone, deepened from 4,708 ft.

Dominguez, Los Angeles County: Shell 115 Reyes, 34-3s-13w, flow gas lift 53 bbl., 30.9-gravity, 60 per cent cut, T.D. 4,240 ft., perf. 3,852-3,990 ft., 4,000-44 ft., 4,056-4,155 ft., 4,170-4,228 ft., completed in first Callender zone.

Huntington Beach, Orange County: Signal O. & G. 11 Bolsa, 34-5s-11w, flowed 150 bbl., 26.1-gravity, 5 per cent cut, 190,000 cu. ft. gas, 40/64-in. bean, pressures 460/570 lb., T.D. 2,750 ft., perf. 2,519-2,748 ft., completed in Bolsa zone.

Southwest Expl. 38 State, 10-6s-11w, pumped 575 bbl., 23.1-gravity, 0.3 per cent cut, T.D. 5,742 ft., perf. 4,787-5,742 ft., completed in tideland accumulation by directional drilling.

Long Beach, Los Angeles County: Union 4 Oil Operators, 13-4s-13w, pumped 71 bbl., 23.1-gravity, 1.5 per cent cut, T.D. 5,365 ft., perf. 5,113-37 ft., 5,280-5,322 ft., deepened from 4,408 ft. to 5,379 ft. and P.B. to 5,365 ft.

Montebello, Los Angeles County: Kern Oil Co., Ltd., 4 Mulholland, 2-2s-12w, flowed gas lift 670 bbl., 35.5-gravity, 1.5 per cent cut, 695,000 cu. ft. gas, T.D. 7,175 ft., perf. 6,640-6,713 ft., 6,950-95 ft., 7,010-75 ft., 7,090-7,120 ft., recompleted in sixth and seventh zones.

Torrance, Los Angeles County: J. E. O'Donnell 74 Torrance, 30-4s-13w, pumped 90 bbl., 18.6-gravity, 8 per cent cut, T.D. 3,668 ft., perf. gravel packed 3,455-3,666 ft., completed in equivalent of Ranger zone.

Wilmington, Los Angeles County: Atlantic Oil Co. 14 Harbor, 33-4s-13w, pumped 81 bbl., 29.1-gravity, 10 per cent cut, T.D. 5,715 ft., set whipstock 3,180 ft. and redrilled to 5,715 ft., landed 5-in. flow string 5,715 ft. with 125-mesh perf. 5,605-5,715 ft., gun perf. 5,080-5,100 ft., 5,325-55 ft., 5,420-40 ft., originally completed in Terminal zone at 3,570 ft., now producing in Ford zone.

Union Pacific R. R. 175 fee, 4-5s-13w, flowed 143 bbl., 30.5-gravity, 0.3 per cent cut, 30,000 cu. ft. gas, 38/64-in. bean, pressures 330/720 lb., T.D. 5,410 ft., 60-mesh perf. 4,740-4,920 ft., 4,967-5,079 ft., 5,222-69 ft., 5,362-5,404 ft., completed in Ford zone.

Union Pacific R. R. 181 fee, 3-5s-13w, flowed 151 bbl., 23.2-gravity, 5 per cent cut, 10,000 cu. ft. gas, 38/64-in. bean, pressures 280/660 lb., T.D. 2,835 ft., perf. 2,593-2,679 ft., 2,696-2,716 ft., 2,739-2,825 ft., completed in Ranger zone.

Wilton Oil Co. 11 Harbor, 32-4s-13w, flowed 154 bbl., 16-gravity, 2 per cent cut, 20,000 cu. ft. gas, 32/64-in. bean, pressures 250/400 lb., T.D. 3,719 ft., perf. 3,148-3,719 ft., completed in upper and lower Terminal zone.

LOS ANGELES BASIN OUTPOSTS OR DEEP TESTS

Dominguez field, Los Angeles County: Union 79 Callender, 32-3s-13w, T.D. 12,720 ft. in basement schist, P.B. 7,490 ft., swabbing and flowing by heads oil and water, elev. 82 ft.

Dominguez extension, Los Angeles County: Crawford and associates 1 Schmeyer, 29-3s-13w, drilling in sand and shale 5,282 ft., elev. 35 ft.

Johnson & Richardson 1 Dominguez, 29-3s-13w, derrick built, scheduled for immediate drilling.

Inglewood field, Los Angeles County: Standard 3-1 L.A.I., 17-2s-14w, T.D. 10,598 ft., P.B. 8,924 ft., will complete in Sentous zone.

Standard 1-85 L.A.I., 7-2s-14w, drilling 3,193 ft. in sand, elev. 325 ft.

R. R. Bush Oil Co. 1 Merchants, 7-2s-14w, drilling in sandy shale 3,084 ft., elev. 190 ft.

R. R. Bush Oil Co. 1 Smith, 7-2s-14w, drilling 2,942 ft., elev. 185 ft.

Federal Oil Co. 2 Smith, 7-2s-14w, drilling 2,896 ft., elev. 215 ft.

Hogan Pet. Co. 8 Machado, 7-2s-14w, rig erected, elev. 100 ft.

Oscar Howard 1 Dominguez, 7-2s-14w, cleaning out old hole, elev. 135 ft.

Jefferson Oil Co. 1 Smith, 7-2s-14w, drilling 6,994 ft. in sand, 12¾-in. surface pipe 773 ft.

Royalty Service Corp. 1 Marlow, 7-2s-14w, building rig, elev. 381 ft.

Texas 7 Smith, 7-2s-14w, drilling 3,650 ft. in sand and shale, elev. 200 ft.

Rosecrans field, Los Angeles County: R. S. Lytle 1 Anderson, 1-3s-14w, location staked and scheduled for immediate drilling, elev. 232 ft.

Southern California Pet. Corp. 1 Townsite, 12-3s-14w, T.D. 8,374 ft., P.B. 8,117 ft., 5½-in. casing 8,117 ft., gun perf. 7,964-8,117 ft., making pumping test.

LOS ANGELES BASIN WILDCATS

Chino district, San Bernardino County: Prado Pet. Corp. 1 Lamp, 31-2s-7w, rigging up rotary-drilling tools and preparing to spud, elev. 560 ft.

East Santa Fe Springs district, Los Angeles County: Sierra Pet. Co. 1 Cole, 2-3s-11w, grading and hauling in material.

Manhattan Beach district, Los Angeles County: Dominguez Ext. Oil Co. 1 Sunset, 19-3s-14w, rig erected over old well of Sunset Oil Co. that was dry at 7,865 ft., elev. 135 ft.

Palos Verdes district, Los Angeles County: Newton Dev. Co. 1 P.V., 13-5s-15w, drilling 929 ft. in sand and shale with cable tools.

Santa Ana Canyon district, Orange County: Valley Pet. Co. 1 Kraemer, 36-3s-9w, T.D. 2,750 ft. in sand and shale, 6⅝-in. casing 2,750 ft., rig to pump, elev. 600 ft.

COASTAL DISTRICT

Western Gulf Oil Co. last week topped an oil sand

(Continued on Page 174)

LOUISIANA GULF COAST

Flank Production Opened on South Flank of Welsh Dome

By F. L. SINGLETON

NEW ORLEANS, La., May 19.—Flank production around another old salt-dome structure in the Louisiana Gulf Coast district was opened as Union Sulphur Co. 1 J. G. Gray located on the south flank of the Welsh dome, Jefferson Davis Parish, flowed 210 bbl. of 37-gravity oil in 20 hours through an 11/64-in. choke. Tubing pressure was 700 lb., and casing pressure 825 lb. An electrical log made the previous week showed favorable indications in a broken sand section at intervals from 6,496-6,571 ft., and after drilling to a total depth of 6,917 ft., 5½-in. casing was cemented on bottom, and the well was completed in the Marginulina sand through perforated casing at 6,534-40 ft.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Fields	8	2,323	54,960
Gas wells: Fields	2	.....	16,053
Dry holes: Fields	2	.....	16,435
Wildcats	2	.....	11,831
Total	14	.....	99,278

First production was established on this structure in 1903 by the Rio Bravo Oil Co., and all production heretofore has been from the Pliocene-Miocene sands at intervals from 1,100 to 1,300 ft. Production from this section has been small, and at a recent date there were 13 producing wells having a daily average production of 22 bbl. While the structure had beeen regarded as a salt-dome structure, it was not until 1939 that salt was first encountered when Stanolind 3-B Bishop in 28-9s-5w topped the formation at 6,458 ft. This led to the drilling of several flank tests, most of which were located on the west flank, and were drilled by Stanolind Oil & Gas Co., Humble Oil & Refining Co., Tide Water Associated Oil Co., and Pure Oil Co.

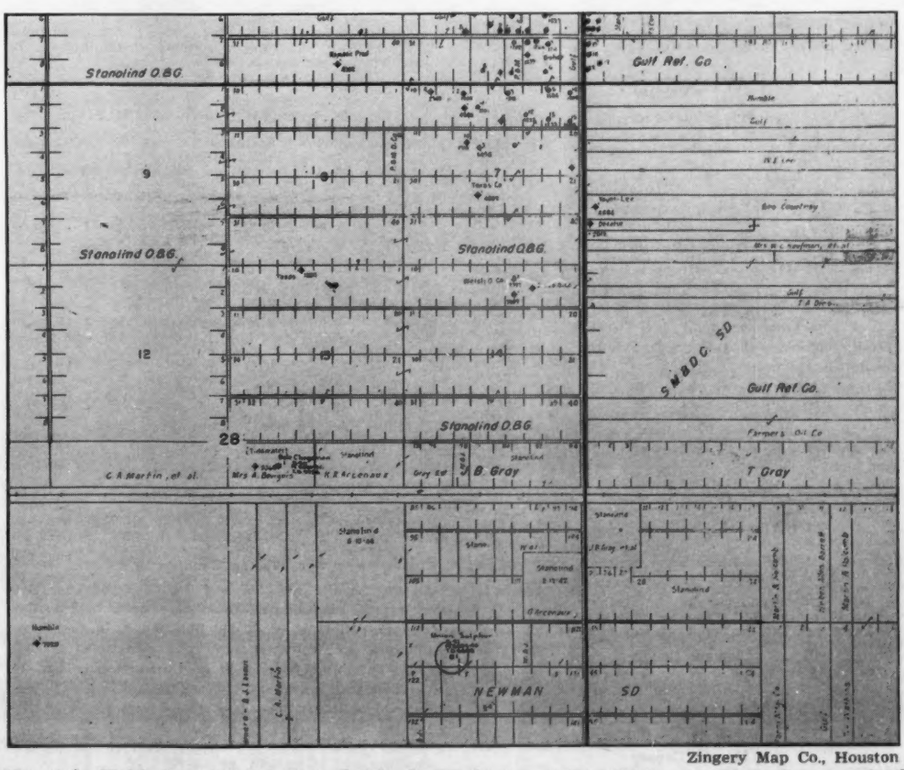
The first test to show for a producer in this deep sand was Chessman & Cranston 1 Bourgeois, just northwest of the present well which tested gas and distillate from two sands at 5,300 ft. and 5,600 ft. However, the well sanded up and the hole was later abandoned when mechanical trouble developed. The Union Sulphur Co.'s well is located in 28-9s-5w, and the rig is being moved over for 2 Bourgeois about 500 ft. due south of Chessman & Cranston 1 Bourgeois, and west of the new producer. Additional development is expected to be announced for this area as protection acreage is held by several companies.

PECAN LAKE.—The Pecan Lake prospect, south of the Grand Lake field, Cameron Parish, was officially opened as a gas-distillate field as Superior Oil Co. of California completed 1-B Miami Corp. for an initial production of 30 bbl. of distillate and an estimated 2,000,000 cu. ft. of gas per day flowing through various chokes. Total depth of the well is 10,887 ft., and completion was made by perforating casing at 10,170-80 ft. Drill-stem testing in this sand section several weeks ago recovered gas and distillate, and the completion was made after only minor showings were logged in deeper sands. The well is in 20-14s-3e.

Rig from the above well is being moved to the Lowry gas-distillate field, north of the Grand Lake field, Cameron Parish, for 1 Calcasieu National Bank, located about 3,200 ft. northeast of the discovery well, which was completed by Lisbon-Iberia Oil Co. about 2 months ago.

EAST OF ERATH.—Although no official gage was available, Phillips 1 Dugas, an east outpost test in the Erath field, Vermilion Parish, is reported to be flowing at the estimated rate of 200 bbl. of oil per day after reperforating casing at 11,618-19 ft. With the

(Continued on Page 179)



Zingery Map Co., Houston

Plat of the Welsh dome, Jefferson Davis Parish, showing location of Union Sulphur Co. 1 J. G. Gray, completed the past week to open production from new sand on south flank of structure

Tensleep Wells at Wertz Show Good Initial Production

By

T. R. INGRAM

DENVER, Colo., May 19.—Fifteen new operations getting under way and eight wells shut down during the winter resuming in the Rocky Mountain area pointed to a week of increasing activity.

Two large Tensleep sand wells in southwestern Wyoming were completed in Sinclair-Wyoming 19-A Wertz, Wertz field, for 1,064 bbl., and 96-A in Lost Soldier, for 1,306 bbl. Two completions in Montana were Santa Rita 13 Tribal, in Cut Bank, for 284 bbl. from two sands, and Texas 2 Willis for 152 bbl.

New operations include a Tensleep sand test for oil in the East Allen Lake gas field by Medicine Bow Oil Co., a test on a high to the southeast of Lance Creek by Western Petroleum Co., and another in the Cumberland district by H. Metzgar.

Deep test on the east side of the Osage field in Osage Trust 1 fee, found 80,000 bbl. of water a day in the lower Minnelusa.

SUMMARY OF COMPLETIONS

Wyoming

	No.	Bbl.	Footage
Oil wells: Fields	2	2,370	10,579
Dry holes	2	.....	2,840
Total	4	.....	13,419

Montana

Oil wells: Fields	2	436	5,718

COLORADO

Pueblo County

E. A. Scriven 1 Kieffer ..... SE SW 21-21s-66w
Drilling 100 ft., Columbia Heights district.

Rio Blanco County

Texas Co. 6 Unit .....NW NE SE 27-3n-94w
Drilling 5,522 ft.
Buford Oil 1 Government ..... C SW SW 16-1n-91w
T.D. 4,387 ft., will resume June 1.

Routt County

Mid-Colorado Pet. 1 Omholt ...NE NE SE 29-4n-87w
S.D. 3,091 ft. in top of Sundance.

WYOMING

Big Horn County

Ohio 2-A Hoskins ..... SE SE SE 15-56n-97w
Spudded, Rocky Mountain Drilling Co. has contract.

Campbell County

Continental-Texas Gulf 1 Knapp NE SW SE 4-56n-69w
T.D. 350 ft., rigging up to resume.

Carbon County

Sinclair-Wyoming 19-A Wertz, SE SW SW 6-26n-89w, Wertz field, was completed at 6,176 ft. in the Tensleep for 1,064 bbl. first 24 hours. Top was at 5,826 ft. and 7-in. was set at 5,828 ft. It is a better well than its offsets, No. 16-A on the west, which made 900 bbl. initial, and No. 13-A on the south, which had an initial of 800 bbl.

Medicine Bow Oil Co. is drilling a deep test to the Tensleep for oil in its 1 Richards, in the East Allen Lake gas field. It is a north offset to 1 Hintze-Government, drilled in 1937, which stopped in the red beds at 2,347 ft. and plugged back. It had 25,000,000 cu. ft. of gas in the upper Sundance at 2,035-58 ft. and 5,000,000 cu. ft. of gas in the lower sand topped at 2,096 ft.

Medicine Bow Oil 1 Richards....C SE NE 18-22n-78w
Drilling 1,839 ft. with rotary, first report.
Ohio 13 State.....NW NE 34-20n-78w
Coring 3,706 ft. in Dakota, top 3,630 ft.
Sinclair-Wyoming 5-C Mahoney. C NW SE 34-26n-88w
Drilling 4,437 ft. in Tensleep, top 4,304 ft

Fremont County

Indian Oil 2 Tribal.....SW SW NW 23-6n-2w
T.D. 1,462 ft., preparing to set 7-in., top Embar 1,320 ft., slight saturation 1,455-62 ft.
V. M. Kirk 2 Tribal.....NW NE SE 22-6n-2w
Drilling 845 ft., water at 832 ft.

Lincoln County

H. Metzgar 1 Government. CEL SW SW 32-19n-116w
Drilling 250 ft. with rotary, show oil 160 ft., first report, Cumberland district.

H. C. Harris 1 Government SE NW NW 23-21n-117w
Drilling 3,225 ft.

Natrona County

General Petroleum 31-27-P...NW NE NW 27-35n-77w
Location.
Casper Creek Oil 1 State.... SW SW NW 36-36n-81w
T.D. 2,386 ft., running 5⅞-in.
K. S. Albert 1 Young.....NE SE 25-32n-82w
Drilling 1,020 ft., Wall Creek sand dry.

Niobrara County

Lance Creek had one new operation and two old wells deepening from the Sundance to the Leo sand. Continental 3-A Schuricht, completed at 3,824 ft. in the Sundance in 1936 for 1,040 bbl., and Ohio 6 Converse Sheep, completed in the Sundance in 1936 at 3,803 ft. for 1,680 bbl. initial, are the two deepening operations.

Western Petroleum 1 Mosier, a test on the Dakota high, southeast of Lance Creek, for which location was made last winter, has spudded.

Continental 3-A Schuricht.....C SW NW 5-35n-65w
T.D. 3,824 ft., building rig to deepen.
Ohio 6 Converse Sheep.....NE SW SE 32-36n-65w
T.D. 3,803 ft., rigging up to drill deeper.
Argo 17 Elliott.....SW NE NE 6-35n-65w
Building rig, first report.
Western Petroleum 1 Mosier .... SW SW 31-35n-64w
Drilling 244 ft., cemented 10-in. at 202 ft., show gas in Morrison sand at 220 ft.
Continental 25 Tom Bell.....SE SE SE 28-36n-65w
Derrick, waiting on equipment.
Argo Oil 10 Ford.....SE SE NW 33-36n-65w
Drilling 5,359 ft., cemented 7-in. at 5,292 ft., top first Leo 5,310 ft.
Ohio 4 Richard & Comstock.....NE SW 32-36n-65w
Drilling 3,511 ft.
Continental 8-A Schuricht.....NW NE SE 6-35n-65w
Drilling dolomite at 5,267 ft., top red marker 4,955 ft.
Ohio 20 Putnam .....NW NW SW 33-36n-65w
T.D. 5,436 ft., running 7-in.

Park County

Stanolind 4 Rosenberg.....NE NW NE 26-58n-98w
Drilling 3,365 ft.
Stanolind 21-X Rosenberg .. NE SW NW 25-58n-98w
Drilling 753 ft.
Enalpac Oil & Gas 2 McMahon O.P.C.-1 .....
C SW SW 32-51n-100w
Rigging rotary.
Texas Co. 5 Sonners ..... SE NE NE 30-51n-100w
Drilling 2,016 ft.
Enalpac 3 Pauline O.P.C.-1 .. SW SE SE 5-51n-100w
T.D. 3,816 ft., in Tensleep, swabbed 115 bbl. in 12 hr., waiting on pump.

Sublette County

Sunset Oil 1-X Government NE SE NE 10-29n-113w
Skidded rig from No. 1, hole lost at 248 ft., Big Piney district.
Klumpe Syndicate 1 State... NE SW NE 28-27n-113w
T.D. 1,792 ft., testing show of gas at 1,512 ft.
Marvel Oil 1-L Government....SE SE SE 28-27n-113w
Drilling 1,018 ft.
Charles Lackey 1 Government..NE SE SW 33-27n-113w
S.D. 1,650 ft.
Texas Co. 1-K Government....NW SW SW 27-27n-113w
Spudded.

Sweetwater County

Sinclair-Wyoming 96-A, NE SE NE 10-26n-90w, Lost Soldier field, was a good completion in the Tensleep at 4,403 ft., total depth. Top of the Tensleep was at 4,047 ft., and the 7-in. was set at 4,049 ft. It flowed 1,306 bbl. in 24 hours. It is a southwest offset to No. 95-A, which was completed in March of this year for 900 bbl. initial.

Mountain Fuel Supply 2 Newburger .....
SW NW NW 18-12n-99w
Location.
Sinclair-Wyoming 101 Govt. NW NW NW 11-26n-90w
Spudded.
Rocky Mt. Drlg. Co. 1 State. SW SW SW 36-20n-104w
T.D. 5,850 ft., fishing for drill pipe.
Sinclair-Wyoming 100-A.....NE NE NE 10-26n-90w
Drilling 906 ft., 13⅜-in. at 437 ft.

Weston County

Osage Trust 1 fee, NE SW SE 10-46n-63w, a deep test on the east side of the Osage field, had a flow of water, estimated at 80,000 bbl. a day, in the lower Minnelusa at 2,574-92 ft., and was abandoned at that depth. The Muddy sand is at the surface. Tops of other sands were Dakota, 200 ft.; Lakota, 374 ft.; basal Sundance, 1,015 ft. The first Leo was cored at 2,155-2,200 ft.

Whedon Oil 8 ..... CWL SW NE 16-46n-64w
Drilling 147 ft., 6⅝-in. at 63 ft.
Updike Brothers 4 ..... CWL SW SW 30-46n-63w
T.D. 1,478 ft., will set 6⅝-in. on top of Muddy at 1,467 ft.
Al Jones 15.....NW NW NE 21-46n-63w
S.D. 335 ft., show oil in Muddy at 335-36 ft.
John Brorphy 1 Hansen.....NW NE NW 13-44n-63w
Drilling 2,300 ft., carrying 6⅝-in. to land on top of Muddy sand.

MONTANA

Cascade County

Bushfort Pet. Synd. 1 Shannon-Roberts .....
C SW NE 12-20n-1e
T.D. 3,300 ft., preparing to acidize and test.

Carbon County

Alex Beaton 1 Government.....CSL SE SE 23-6s-23e
S.D. 1,645 ft. for 5⅞-in.

Fallon County

Carter Oil 1 Northern Pacific Unit C SE SW 19-4n-62e
Rigging up rotary.
Mondakota Dev. 1 Seargents . SW SW SW 32-8n-60e
T.D. 910 ft., 4½-in. at 860 ft., preparing to test.

Fergus County

Tony Co. 2 Scharf.....NW SE NW 36-22n-17e
Drilling 560 ft.

Garfield County

California Co. 4 Charles .....C SE NW 21-15n-30e
Drilling 3,965 ft. in lime.

Glacier County

Cut Bank had two completions and one new operation. The most interesting was Santa Rita 13 Tribal, CSL NE SW 10-35n-6w, in what is generally known as the Lander pool, where the largest well in the field, a Sunburst sand producer, was completed. This well is on the same trend as the Sunburst sand wells. It was completed at 2,938 ft., and from the combined sands swabbed 284 bbl. in 24 hours. The Sunburst had saturation at 2,825-35 ft. and was dry at 2,837-88 ft. In a swabbing test before drilling into the Cut Bank it made 190 bbl. in 24 hours. The Cut Bank was at 2,865-2,930 ft., with the main pay at 2,920-30 ft.

Texas 2 Willis, SW SW SW 20-32n-5w, swabbed 152 bbl. in 24 hours at 2,780 ft. from the Cut Bank sand at 2,715-55 ft. The main pay was at 2 748-55 ft. The 7-in. is at 2,732 ft.

Santa Rita 14 Tribal ..... NW NW NW 10-35n-6w
Rig, first report.
Pioneer Lumber 1 Anderson...NW NE NW 31-32n-5w
Building rig.
Consolidated Gas 2 Frary-Tribal-191 .....
NW SW NE 19-32n-5w
Spudded.
Anderson 6 Anderson.....NW SW NE 26-35n-6w
Cemented 10¾-in. at 504 ft., top Colorado 465 ft.
Ed Reagan 1 Tribal-194.....CEL SE NE 22-37n-7w
T.D. 3,869 ft., testing.

Hill County

Cobb-Yale 1 Government.....C SW NE 19-37n-15e
Drilling 2,900 ft.

Phillips County

Montana-Dakota Utilities released six new operations in the Bowdoin field. After spudding and setting surface pipe, they are shut down until they are reached in rotation for completion with rotary.

Montana-Dakota Utilities 649 Kippen .....
C NW NE 25-32n-33e
S.D. after cementing 8⅝-in. at 102 ft.
Montana-Dakota Utilities 644 Robinson .....
C NW SW 15-32n-33e
Cemented 8⅝-in. at 100 ft. and S.D.
Montana-Dakota Utilities 636 Kemp C NE NE 25-32n-34e
Cemented 8⅝-in. at 105 ft. and S.D.
Montana-Dakota Utilities 635 Martin .....
C SE NW 25-32n-34e
Drilling 1,093 ft., 8⅝-in. at 104 ft.
Montana-Dakota Utilities 634 Kippen .....
C SW SW 20-32n-34e
Cemented 8⅝-in. at 101 ft. and S.D.
Montana-Dakota Utilities 633 Kohnlein .....
C Lot 2, 30-32n-34e
Cemented 10¾-in. at 100 ft. and S.D.

Teton County

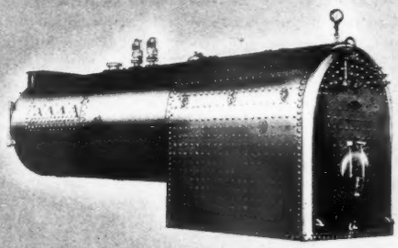
R. C. Tarrant 1 Kellogg..... SW NW NE 33-27n-5w
Drilling 1,400 ft.

Toole County

Big West 6 Ellingson ..... SW SW SE 14-35n-3w
Spudded, first report.
J. H. Agen 14 Goeddertz .... CNL SE NW 23-35n-3w
Spudded, first report.
Superior Petroleum 4 Haugen SE NE NE 11-35n-3w
Drilling 500 ft., first report.
M. F. Toles 2 Blumberg.... NW NW NE 32-35n-3w
Cemented 7-in. at 1,605 ft.

(Continued on Page 172)

STEAM OR DIESEL



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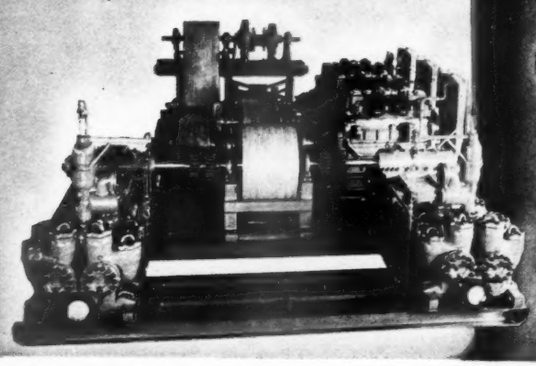
This three-engine Diesel outfit is designed for high-powered economical drilling to 12,000 feet. Engines are full Diesel of 200 to 300 horse power, mounted on toboggan-type skid bases. Flexible hook-up permits easy changeovers for compounding engines to drive either drawworks or pumps. Pumps are Wheland-Lucey HP-15000-AD 7¾"x18" on ground level with engines. Reverse clutch on substructure at derrick floor level. Entire hook-up arranged for field transportation in sections.



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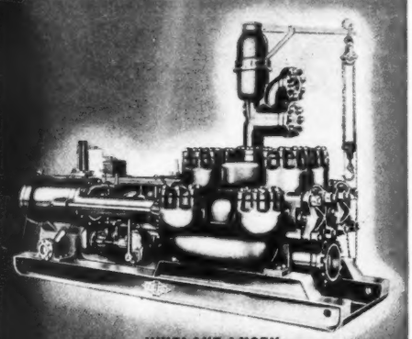

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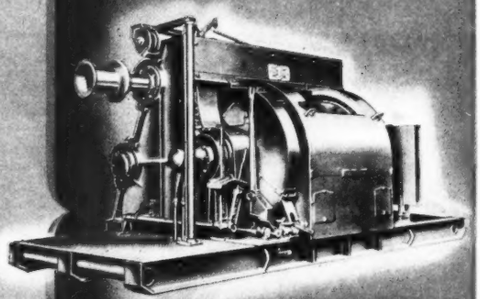

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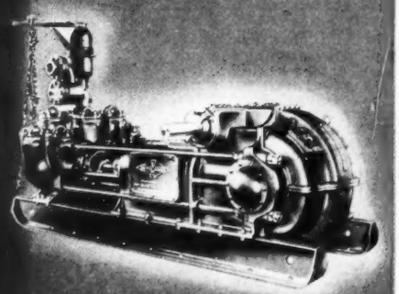

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CANADIAN FIELDS

Eight Turner Valley Wells Near Completion Stage

By VICTOR LAURISTON

CHATHAM, Ont., May 19.—Crude and natural-gasoline production from all Alberta fields for the week ending May 5 averaged 26,489 bbl. a day compared with 27,155 bbl. daily for the previous week. The daily average included 25,468 bbl. of crude and 846 bbl. of natural gasoline from Turner Valley; 77 bbl. from the Steveville-Princess field, and 98 bbl. from other fields. Daily averages for the week ending May 6, 1940, were: Turner Valley crude, 20,754 bbl.; Turner Valley natural gasoline, 688 bbl.; other fields, 75 bbl.; a total for Alberta of 21,517 bbl. daily. Producing wells for the week ending May 5, 1941, were 147 in Turner Valley and 16 in other fields, compared with 106 and 14 for the corresponding wek last year.

Turner Valley Lime Tests

NORTH TURNER VALLEY.—Major Oil Investments 1, LSD 5, 34-20-3w5, is below 7,504 ft., more than 1,098 ft. in the Madison limestone. This, the most northerly test to get the Madison, appears to have encountered faulting in the lime similar to Royalite 35, which entered the Madison at 6,173 ft. and finished in the black lime at 7,381 ft. Major 1 indicated good porosity in the upper porous zone.

NORTH CENTRAL SECTION. — Empress Royalties 1, LSD 5, 2-20-3w5, is getting into the Madison limestone below 8,680 ft.

WEST CENTRAL SECTION. — Atlas Royalties 1, 24-19-3w5, got the Madison at 7,588 ft., and is resuming after cementing 7-in. casing at 7,612 ft.

Twin Valley Syndicate 2, LSD 10, 13-19-3w5, got the limestone at 7,987 ft. and is deepening below 8,061 ft. after cementing casing. Sunray Petroleums 1, LSD 8, is below 7,971 ft., after getting the lime at 7,816 ft.

Southwest Petroleum 5, LSD 2, 8-19-2w5, finished at 6,955 ft., 456 ft. in the lime, is acidizing and testing.

Royalite Oil 55, LSD 7, 7-19-2w5, got the lime at 7,179 ft. and is deepening after cementing production string at 7,199 ft.

SOUTHWEST SECTION.—Northwest-Hudson's Bay 5, LSD 10, 8-18-2w5, finished at 8,487 ft. is acidizing and testing, with indications of a good producer.

Other Alberta Tests

POUCE COUPE.—Guardian Oil 1, 7-80-12w-6, bottoming at 6,640 ft., is reported testing oil showings in the Triassic formation preparatory to deepening.

CLEARWATER.—Ram River Oils 2, 1-37-11w5, standing in Devonian limestone at 3,000 ft. Clear Oils 1, LSD 8, 2-35-10w5, is in Devonian limestone below 2,136 ft.

BLOOD INDIAN RESERVE.—Northwest-West Petroleum 1, LSD 3, 20-5-23w4, got the Madison limestone at 6,120 ft. and the Devonian at 7,290 ft. Drilling was discontinued at 8,082 ft. The Devonian failed to show production and the hole was cemented back to 6,090 ft. and redrilled to 6,160 ft. to test the Madison. Some oil was shown, but water broke in, and the well was plugged back to 6,085 ft. and redrilled to 6,130 ft., and acidized for a further test. This showed some oil, but failed to develop commercial production, and the well was abandoned. A second test, to be known as Northwest-Treaty 1, has been located on the Wild Turnip Hill structure in LSD 4, 17-8-23w4, about 2 miles north of the first well. The structure covers approximately 18,000 acres jointly controlled by Northwest Co., subsidiary of Imperial Oil, and Treaty Petroleum.

Eastern Alberta

STEVEVILLE. — Standard of British Columbia 4 Princess, LSD 13, 12-20-12w4, got the Madison limestone at 3,278 ft. and cemented casing at 3,323 ft. It is perforating, acidizing, and testing production. Standard 5 Princess, LSD 9, 14-20-12w5, got the lime at 3,218 ft. and is finishing below 3,271 ft. Standard 3, LSD 5, 13-20-12w4, is continuing production tests after recementing. It got an indicated production of 85 bbl. daily with 1,500,000 cu. ft. of gas from an horizon above the lime, believed to be the Sunburst sand, but has had difficulties with water intrusion. Anaconda-Patricia 1, LSD 3, 31-20-12w4, has resumed after cementing 10-in. casing at 471 ft. Steveville Oils 1, LSD 5, 18-20-11w4, is below 3,899 ft., 622 ft. in the Madison, with the Devonian contact expected around 4,000 ft. No commercial production was encountered either above or in the Madison.

VERMILION.—Richardson 1 Western, LSD 14, 20-50-5w4, finished at 1,825 ft., has been placed on production and is pumping a fair quantity of heavy crude.

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MICHIGAN OPERATIONS

Big Well in Winterfield Promises Development

By OTTO C. PRESSPRICH

SAGINAW, Mich., May 19. — Sun Oil Co., chief operator in the area, completed the Winterfield pool's best well to date and indicated high hopes for a profitable development by paying the state the biggest lump sum in 3 years for rights on state-owned lands.

Acid treatment jumped production of Sun 2 Strange in Section 36 from 400 bbl. natural to 1,540 bbl. a day. Meanwhile Sun prepared for two more tests in the area and Chapman Oil Co. has made arrangements to drill two others.

Elsewhere in Michigan the week was about average with three small producers being added to the Ottawa County production, while two other producers were completed in Allegan County, one other in Clare and still another in Kent. Two small natural-gas wells were included in the list of completions while seven tests were listed as dry in seven counties.

Sun paid $8,000 for 71 acres in leasing land in Winterfield just north of production the company has developed. One other bidder stopped at $7,700. The Conservation Department auction leased rights on more than 20,000 acres for a total of $15,400. In Roscommon County approximately 6,000 acres were leased at prices up to $3 an acre. The rest of the acreage is in other northern Michigan counties.

Meanwhile Cities Service Oil Co. was completing 1 Phareas in Section 32 of West Winterfield as a south offset to the Wyman discovery, but Turner Petroleum Co. 1 Wiegert in Freeman-Clare was dry at 4,005 ft. It was a wildcat.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Allegan	2	115	3,201
Clare County	2	1,590	7,575
Kent County	1	65	1,930
Ottawa County	3	110	5,512
Gas wells: Isabella	1	*0.7	1,345
Kent County	1	*1.2	1,181
Dry holes: Allegan	1	.....	1,576
Calhoun County	1	.....	1,606
Clare County	1	.....	4,005
Lake County	1	.....	1,259
Missaukee County	1	.....	1,260
Montcalm County	1	.....	3,346
Ottawa County	1	.....	1,980
Total	17	.....	35,776

*Million cu. ft.

Two other wildcat tests are drilling in Lincoln Township, and one in Summerfield. In Redding, where Sun 1-B State was completed for 50 bbl. after acid in Section 5, American Drilling Co. reported hole full of oil in 1 Spring, Section 29. American Drilling Co. 3-X State, also in Section 29, is due for completion.

(Continued on Page 183)

Cockfield Oil Production Opened in Garwood Area

By NEIL WILLIAMS

HOUSTON, Tex., May 19.—The search for oil production from the Cockfield sand in the Garwood area, Colorado County, came to an end the past week with the completion of W. R. Davis 1-B Brownston which flowed 320 bbl. of 43-gravity oil per day through a 7/64-in. choke. Tubing pressure was 890 lb. and casing pressure 1,050 lb. Total depth of the hole is 6,310 ft. and production is through perforated casing at 6,104-08 ft.

Development of this structure which is located in the southwestern part of the county dates back to 1929 when approximately four shallow tests were drilled by the Coyle-Concord Oil Co. The area was later worked extensively with torsion balance, magnetometer and other geophysical instruments which resulted in drilling of the first real test in the area. This was Coyle & Concord 1 Nelson in Section 43, I.&G.N. Survey, which was drilled to a total depth of 6,194 ft. and completed in July 1932 as a gas well in the Frio sand at 4,041-25 ft. At the time this well was drilled the company controlled a block of approximately 20,000 acres in the area, and this acreage was later assigned to Humble Oil & Refining Co., Plymouth Oil Co., and Sterling Oil & Refining Co.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Lolita	2	133	11,709
West Ranch	5	273	28,071
Other fields	10	2,194	69,586
Dry holes: Fields	1	.....	7,830
Total	18	.....	117,196

Promise of Cockfield production was first indicated in 1933 by Plymouth 1 Reams in Section 47 which showed for a producer in sand at 6,145-6,203 ft., the total depth, but the well was later abandoned due to salt-water encroachment. Since the drilling of this well, approximately 12 Cockfield tests have been drilled at various times, five of which resulted in gas-distillate producers.

Drilling was halted in 1939 and was not resumed in 1940 when acreage in the area was acquired from Coyle-Concord by the W. R. Davis Co. After drilling one deep Wilcox test in which promising showings were encountered, the company made location for another Wilcox test and this well, 1 Brownston, was completed in January of this year as a gas-distillate producer in the Wilcox sand at 9,423-38 ft.

The Cockfield producer is located in the A. B. Fisk Survey No. 824 about 2,700 ft. northeast of the Wilcox producer, and about 1½ miles distance southwest of previous development. Correlated with the Wilcox producer 1-B Brownston is approximately 25 ft. structurally lower, and about 50 ft. higher than the nearest dry holes. The company has made location for a second test, about 933 ft. due west in the same survey.

WEST CONROE.—Housh & Thompson 2 Clary which showed promise of opening the first crude production in the West Conroe field, Montgomery County, is preparing to retest after it flowed an estimated 1,500,000 cu. ft. of dry gas per day with no show of oil when tested through perforated casing at 4,730 ft. and at 4,733 ft. Tubing pressure built up to 1,625 lb. This well which is located southeast of the discovery well, recovered several hundred feet of 36-gravity oil on a recent drill-stem test in the Cockfield sand at 4,731-34 ft. Should the test fail, the well will be drilled to the Wilcox formation which is expected at about 8,500 ft.

HALLS BAYOU.—Prospects of opening commercial production in the Halls Bayou area, Brazoria County, were not encouraging as Strake 1 Griffith continues to show salt water. The latest test was made at 10,328-33 ft., and the well flowed salt water, and working pressure built up to 2,800 lb. This well has been in the process of completion for the past several weeks, and the hole has been plugged back and sidetracked twice due to mechanical trouble resulting from excessive gas pressure.

LAKEVIEW.—In the Lakeview area, Wharton County, W. R. Davis Co., Inc., continues to test 1 Hartman, and the well is generally conceded as having a chance of opening gas or distillate production. Drill-stem testing at 3,417-19 ft. recovered 30 ft. of oil and 150 ft. of drilling mud, while a test at 3,415-19 ft. tested 4 lb. working pressure and recovered 210 ft. of gas-cut mud. Another test at 3,413-15 ft. tested 530 lb. working pressure and 2,610 ft. of gas-cut mud was recovered. These perforations have been squeezed off and another test was scheduled to be made at the close of the week.

DYERSDALE EXTENSION.—Another producer was apparently assured the extension area of the Dyersdale field, Harris County, as Jack Frazier 1 R. A. Alcorn is bottomed at 4,067 ft., with 5½-in. casing cemented at 4,058 ft. An electrical log showed Miocene sand at 3,480-3,503 ft. and Frio sand at 4,058-66 ft. Casing was cemented on top of the sand, and the well was cleaning into the pits at the end of the week. This is the second well completed in this area which is located about 2,000 ft. northwest of the field proper.

New Wildcat

In southwestern Orange County near the town of Vidor in the T. H. Breese Survey, William Dickey staked location for a wildcat test in the Locke lease.

TEXAS GULF COAST COMPLETIONS

Brazoria County

Hastings field: Stanolind 21 Sneed, 600 bbl., ¼-in. choke, perf. casing 5,586-5,616 ft., T.D. 5,675 ft.

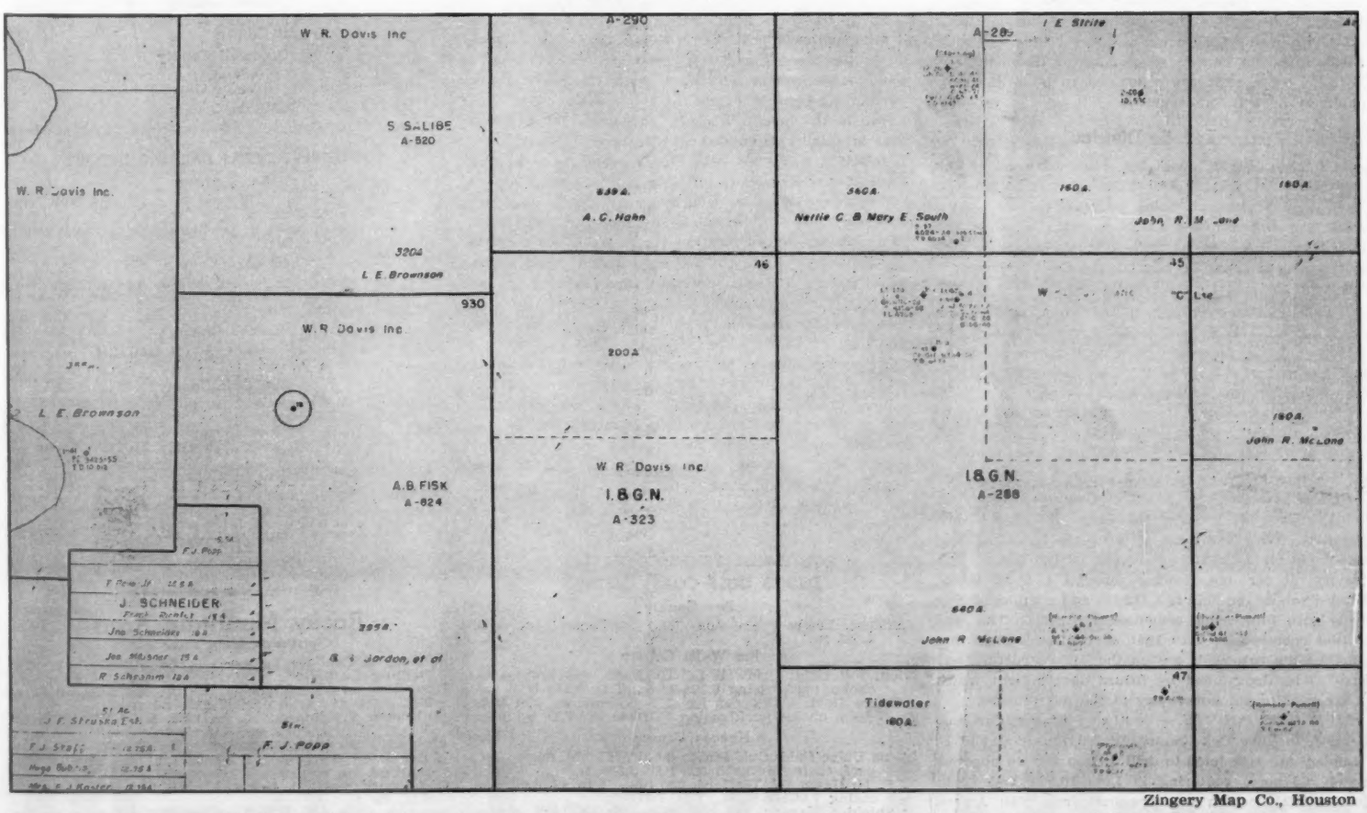
Old Ocean field: Harrison & Abercrombie 1 Meador, 236 bbl., 12/64-in. choke, top sand 10,030 ft., T.D. 10,478 ft.

Harrison & Abercrombie 3 Osborn, 300 bbl., 20/64-in. choke, top sand 9,962 ft., T.D. 10,490 ft.

Galveston County

Caplen field: Sun 1 Eddington Pool, 172 bbl., ⅛-in. choke, perf. casing 6,242-54 ft., T.D. 7,755 ft.

(Continued on Page 193)



Zingery Map Co., Houston

W. R. Davis 1-B Brownston (indicated by circle) completed the past week to open the first crude production in the Garwood area Colorado County

By
F. L. SINGLETON

Deeper Production Indicated For La Gloria Field

CORPUS CHRISTI, Tex., May 19.—Promise of deeper production being opened in the La Gloria field of Jim Wells County was indicated by the attempted blowout of Magnolia 1 Church of the Brethren, located about 1 mile south of gas-distillate production. The well started to "kick" while coring in sand at 8,043 ft., the total depth, and it was brought under control by pumping in 1,000 sacks of cement. The drill stem is said to have become stuck and the crew was waiting on orders at the close of the week. This was a projected 6,700-ft. test, but the hole was drilled deeper when no shows were logged in the regular pay. The Vicksburg was topped at 7,383 ft., and the Warrenite at 7,716 ft.

In the same county, and located in the newly opened Sellig field, Magnolia 1 Seeligson Unit 3 was drilling in shale below 4,900 ft. after two drill-stem tests at 4,798-4,800 ft. and 4,864-70 ft. showed only drilling mud. The well is located in Section 61 of the Haldeman Survey. It is a semiwildcat test for the area, being located several thousand feet from the company's 1 Seeligson Unit 4, the discovery well, completed several weeks ago in sand at 5,017-38 ft. Another location has been announced for the field, being the company's 1 C. M. Laughlin in the H. D. Koopman Survey 235, about 1,450 ft. east of the discovery well.

NUECES COUNTY.—Midway between the Stratton and Agua Dulce fields, Nueces County, R. H. Hawn is moving in material for 2-A and 1-B Bush-Wofford, offsetting the operator's 1 Bush-Wofford, completed the previous week in a new sand lens at 7,001-05 ft. for an initial production of 236 bbl. per day through a ⅛-in. choke.

Locations for two wildcats were announced for the county. Six miles southwest of the Luby field Brown & Wheeler, Inc., are moving in material for 1 Z. A. Booth in the Bishop subdivision of Petronilla ranch, Block 13. Some 2½ miles southwest of Corpus Christi R. S. Waldron is preparing to spud 1 Singer, Lot 16, Block E of the Paisley subdivision of Hoffman tract. Both of these tests are scheduled to be drilled to a depth of 7,000 ft. or deeper.

Laredo District

In Laredo district, about 3½ miles southeast of Randado, Neuhaus, Adams et al 2 Gallagher is bottomed at 3,464 ft., and casing is being cemented to test sand at 2,856-68 ft., which tested 700 lb. working pressure. This is the second test to be drilled, being located a short distance from Texas Gulf Producing Co. 1 Gallagher, a dry hole.

In the northwestern part of the county and located south of the Guerra field, T. B. Hoffer et al 1 Guerra is reported to have cored sand with a showing of oil and gas at 3,645-65 ft., and 5½-in. casing is being cemented on bottom for a production test.

The showings of the above wells are expected to result in an increase in wildcatting along this trend, which is already one of the most active areas in this particular district.

DUVAL COUNTY.—In Duval County Bridwell Oil Co. 1-B Escapule, east of the Loma Novia field and about 1½ miles southwest of the Kreis field, has been completed for an initial production of 148 bbl. of 30.3-gravity oil per day, flowing through a ¼-in. choke. Total depth of the hole is 3,212 ft., and completion was made with 7-in. casing cemented at 3,204 ft. The sand section corresponds with that of the Kreis field, but whether the two wells are on the same structure will have to be determined by future development which is expected to get under way in the near future.

LIVE OAK COUNTY.—Southeast of the Carolina-Texas field, Live Oak County, W. F. Houser and R. F. Campbell are scheduled to drill a deep test on approximately 60 acres centering in Lots 10, 11 and 12 in Survey 702½ which was acquired from Pan American Production Co. on a farmout deal. Protection around the location is held by several major companies.

Tentative location for a Wilcox test is reported to have been made on a block of about 6,500 acres near the town of Zapata in Zapata County centering in Porcions 36, 37 and 38. The well is to be drilled by Ralph E. Fair.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Lower Gulf Coast District			
Oil wells: Stratton	1	92	6,637
Agua Dulce	3	506	20,262
Other fields	5	835	26,451
Dry holes: Fields	2	.....	12,199
Wildcats	1	.....	4,506
Total	12	.....	70,055
Laredo District			
Oil wells Fields	5	570	15,704
Gas wells: Fields	1	.....	2,155
Dry holes: Fields	2	.....	7,443
Wildcats	4	.....	12,655
Total	12	.....	37,957
San Antonio District			
Oil wells: Fields	2	.....	3,111
Dry holes: Wildcats	1	.....	1,930
Total	3	.....	5,041

WEBB COUNTY.—Shell Oil Co., Inc., is reported to have dropped its option on approximately 200,000 acres of the Callaghan ranch in Webb County. The acreage was dropped after extensive geophysical work had been done.

Balcones Fault Line

In the Balcones fault-line district, and located about 1 mile south of the Elm Creek field, Guadalupe County, R. T. Newton 1 Vorphal is reported to have topped a sandy shale section showing oil at 1,112 ft., and 5½-in. casing has been cemented for a production test. Total depth of the hole is 1,153 ft. This is an old well that was originally abandoned at a depth of 1,025 ft.

DIMMIT COUNTY.—In the Carrizo field, Dimmit County, Producers Corp. of Nevada 2 McKnight, a west offset to the discovery well is coring for the discovery sand at 1,900 ft. Two miles south of the field R. R. Mogford announced location for 1 W. L. Barnard in the J. J. Blair Survey, a projected 2,500-ft. test. Northwest of the Catarina townsite and located in the T.&N.O. Survey, Humble 1 Catarina Farms has been abandoned in shale and chalk at a total depth of 6,613 ft.

In Nueces County, and located about 2 miles northwest of the Shield field, Phillips 1 Mastin, a wildcat which was abandoned in 1938 at a total depth of 7,765 ft., is being tested after an electrical survey showed possible production. Five and one-half inch casing was cemented at 6,697 ft., and a test is scheduled to be made in the Shield sand at 6,600-10 ft. A 3-hour drill-stem test at 6,610-15 ft. recovered 5,540 ft. of salt water on a 3-hour test.

SOUTHWEST TEXAS COMPLETIONS

LOWER GULF COAST DISTRICT

Bee County

Wildcat: Lewis Production Co. 1 McKinney, dry, T.D. 4,506 ft.

Jim Wells County

Ben Bolt field: Bridwell 1-C Hoffman, 395 bbl., ⅞-in. choke, perf. casing 5,228-34 ft., T.D. 5,254 ft.
Orange field: Cities Service 2 Schuenmann, 129 bbl., ⅞-in. choke, perf. casing 5,070-80 ft., T.D. 5,120 ft.

Nueces County

Agua Dulce field: Gulf Plains 5 Eliff, 25 bbl. open flow, perf. casing 4,830-45 ft., T.D. 6,500 ft.
R. H. Hawn 1-A Wofford, 236 bbl., ⅛-in. choke, perf. casing 7,001-05½ ft., T.D. 7,210 ft.
Shield 1 Harvey, 245 bbl., ¼-in. choke, perf. casing 6,420-30 ft., T.D. 6,452 ft.
Clara Driscoll field: Magnolia 7 Driscoll, 86 bbl., ¼-in. choke, perf. casing 3,817-18 ft., T.D. 3,825 ft.
Shield field: Shield 3-B Lewis, 110 bbl., ⅛-in. choke, perf. casing 6,609-19½ ft., T.D. 6,620 ft.
Stratton field: Southern Minerals 5 Sellers, 92 bbl., 3/32-in. choke, perf. casing 6,613-21 ft., T.D. 6,637 ft.

Refugio County

Fagan field: Simmon & Norsworthy 2 Fagan, dry, T.D. 5,850 ft.
La Rosa field: Royal O. & G. Co. 7-A Schirmer, dry, T.D. 6,349 ft.

Victoria County

Keeran field: Barnsdall 11 Keeran, 115 bbl., 7/64-in. choke, top sand 5,616 ft., T.D. 5,632 ft.

LAREDO DISTRICT

Brooks County

Kelsey field: Magnolia 6 State, 194 bbl., ¼-in. choke, perf. casing 4,721-25 ft., T.D. 4,732 ft.

Duval County

Casa Blanca field: Magnolia 16 Duval County Ranch Co., 33 bbl., ⅜-in. choke., T.D. 1,028 ft.

Jim Hogg County

Colorado field: Humble 13-B King, 174 bbl., ⅞-in. choke, T.D. 2,926 ft.

Live Oak County

Wildcat: Humphries & Hotchkin 2 Hamilton, dry, T.D. 1,376 ft.

McMullen County

Wildcat: Bancroft Drilling Co. 1 J. E. Murphy, dry, T.D. 3,010 ft.

Starr County

Rincon field: Continental 21-A Slick, dry, T.D. 5,393 ft.
Sun field: Humble 3 Montalvo, 117 bbl., ⅛-in. choke, T.D. 4,859 ft.
Wildcat: W. R. Davis Co., Inc. 1-C Davenport, dry, T.D. 5,509 ft.

Webb County

Glen field: Interstate Minerals, Inc. 63 Lopez, 52 bbl., ¼-in. choke, sand 2,143-59 ft., T.D.
Transwestern 14 Yeager-Stroman, gas well, top sand 2,140 ft., T.D. 2,155 ft.
Killam field: O. W. Killam 13 Garcia, dry, T.D. 2,050 ft.
Wildcat: J. M. Anderson 1 Benavides, dry, T.D. 2,760 ft.

SAN ANTONIO DISTRICT

Bexar County

Gas Ridge field: Southwest Drilling Co. 14 Covell, 2 bbl., pumping, T.D. 461 ft.

Caldwell County

Tenney Creek field: Wiegand Brothers 2 W. C. Hill, 66 bbl., flowing by heads, chalk 2,358-2,650 ft., T.D.

Milam County

Wildcat: W. S. Shadrach 1 Donaldson, dry, T.D. 1,930 ft.

SOUTHWEST TEXAS DRILLING REPORT

Bee County

Crown Central 1 T. J. Welder, J. M. Planes Sur., coring shale 2,368 ft.
Hewitt & Dougherty 1 L. E. Weiss, J. M. Uranga grant, coring shale 8,365 ft.

Hidalgo County

W. R. Davis Co., Inc., 1 Arizona & Texas Citrus Co., 5,100 ft., southwest of discovery well, McAllen field, drilling shale 4,558 ft.

Karnes County

Ralph E. Fair 1 John Hancock Mutual Life Ins., coring shale 1,202 ft.

Live Oak County

Continental 1 George West, 2 mi. E of Kitty, drilling shale 2,218 ft.
Edwin M. Jones 3-B West, 4½ mi. SW of George West, T.D. 9,036 ft., drilling bridge at 7,350 ft. Well showing gas.

Nueces County

Humble 1 State, Red Fish Bay, coring shale and sand 8,878 ft. Sidewall core 8,831-34 ft., recovered sandy shale, gas odor.

Webb County

Magnolia 1-A Hamilton ranch, 15 mi. NW of Callaghan, Joaquin Galan grant, drilling 6,415 ft.

Rocky Mountain Area

(Continued from Page 168)

Coolidge & Coolidge 2 Stone.....SE SW SE 26-36n-2w
Drilling 1,210 ft.
Huso Brothers 2 Ellingson.....C SE SE 14-35n-3w
T.D. 1,769 ft., acidized 300 gal., no results.
E. Morton 3 Ellingson.....CNL NE NW 23-35n-3w
T.D. 1,734 ft., contact 1,713-15 ft., installing pump.
Rimrock Production 7 Schmidt CSL SE NW 29-35n-3w
T.D. 1,788 ft., contact 1,766-86 ft., 7-in. at 1,687 ft., acidized, no results.
C. Leonard Smith 1 Lewis.... NE SW NW 34-33n-2e
S.D. 20 ft.
Dunkirk Adventure 1 McKechnie..NW SW SE 2-31n-1w
T.D. 1,305 ft., fishing.

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OKLAHOMA CITY

Lower Devonian Reached in Tests With Oriskany Near

By STAFF CORRESPONDENT

PITTSBURGH, Pa., May 19.—Several tests in the various districts of the lower eastern fields have reached the Lower Devonian and are drilling through to the Oriskany sand. These wells may open new deep pools or extensions and the results are awaited with interest. In the past week 15 completions were reported of which 1 was dry, 13 were gas wells, and 1 oil producer with a daily initial of only 4 bbl.

SOUTHWEST PENNSYLVANIA

In Beaver County, the wildcat of L. D. McMichaels et al on the Elmer Pflug farm on Big Knob, New Sewickley Township, is drilling at 5,411 ft. or 129 ft. in the Onondaga. So far no glauconite which is usually in the last 20 ft. of that member has been found. In Center Township, St. Joseph Lead Co. is drilling at 1,130 ft. in the test on the J. P. Koehler farm.

On Laurel Ridge in Stewart Township, Fayette County, New Penn Development Co., William S. Snee et al are drilling at 8,087 ft. in the wildcat on the Gregg L. Neel farm or 37 ft. below the top of the chert in the Onondaga. So far no gas has been found. In Maryland, these operators are drilling at 5,225 ft. and in a new hole in the test on the Humberson farm on the Accident dome in Garrett County.

On Chestnut Ridge, in Fayette County, Wasson & Co. et al are drilling at 7,286 ft. in 2 J. H. Sorg in North Union Township with the Oriskany sand topped at 7,282 ft. or an interval from the bottom of the casing set in the Onondaga lime at 297 ft. Some added gas is reported from the Oriskany sand.

In South Union Township, Fayette County, on this structure, Peoples Natural Gas Co. is drilling at 4,736 ft. in 4 Piedmont Coal Co. and 440 ft. in No. 5, same tract. Additional locations are expected shortly in this township.

SUMMARY OF COMPLETIONS

Southwest Pennsylvania

	No.	Bbl.	Footage
Gas wells	6	*3.1	12,470
Dry holes	1	.....	3,300
Total	7	.....	15,770

West Virginia

Oil wells	1	4	1,558
Gas wells: Oriskany field	1	*2.3	4,946
Others	6	6.8	15,745
Total	8	.....	32,249
Recompletions	1	*0.1	.....

COMPLETIONS

Armstrong County

Red Bank Township: Local Co. 1 Samuel Kunselman, 54,000 cu. ft. gas, Bradford sand, T.D. 3,285 ft.
Valley Township: Humphrey, Stone & McCall 1 G. M. Slease, 1,350,000 cu. ft. gas, Fifth sand, T.D. 1,592 ft., R.P. 730 lb.

Greene County

Cumberland Township: Equitable 1 Nellie B. Gideon, 1,000,000 cu. ft. gas, Big Injun sand, T.D. 1,653 ft.
Richhill Township: Charles Hart et al 1 Ross Galloway, 215,000 cu. ft. gas, Big Injun sand 1,481 ft., gas 1,563 ft., T.D. 1,566 ft.
Wayne Township: Lee Wise et al 1 Henry Hixenbaugh. 379,000 cu. ft. gas, Big Injun sand 2,217 ft., gas 2,237-43 ft., T.D. 2,259 ft.

Clarion County

Piney Township: Frank Shreffler et al 1 L. E. Gourley, 77,000 cu. ft. gas, Speechley sand, T.D. 2,115 ft.

Indiana County

Brush Valley Township: T. W. Phillips 2 M. J. and S. E. Overdorff, dry through Bradford, T.D. 3,300 ft.

WEST VIRGINIA

The Oriskany test of the United Carbon Co. on the D. F. Hyre farm in Ripley district, Jackson County, proved a good gas well after shot through the sand. The Oriskany was topped at 5,111 ft. and the total depth 5,210 ft. After shot, it gaged 5,628,000 cu. ft. with a rock pressure at the end of 24 hours of 1,880 lb.

In Tygart district, Wood County, the United Carbon Co. et al bottomed the Clinton test on the C. W. Cook farm at 6,297 ft. in the Red Medina with the Clinton sand topped at 6,123 ft. and absolutely void of any showing.

In Ravenswood district, Jackson County, several tests are nearing the Oriskany sand with the following wells drilling in the Corniferous lime; Everett Starcher 1 William H. Archer, Joe Rubin et al 1 H. O. Maddax, Columbian Carbon Co. 4837 J. E. Sweezy. All are wildcats and may open additional gas reserves.

In Monongalia County, Hope Natural Gas Co. is drilling at 3,130 ft. in the Oriskany test on the H. C. Greer lease in Morgan district.

COMPLETIONS

Cabell County

Barboursville district: James Webb, trustee, 1 Harry Hatfield, 462,000 cu. ft. gas, Big lime 1,350-1,532 ft., Big Injun 1,565-1,706 ft., Berea 2,203-13 ft., brown shale 3,008-3,250 ft., gas 2,180 ft. and 3,245 ft., shot, T.D. 3,258 ft.

Gilmer County

Center district: McCall Drilling Co. 1 J. F. Crook, 300,000 cu. ft. gas, Big lime 1,760-76 ft., Big Injun 1,776-1,940 ft., gas 1,821-26 ft., T.D. 1,894 ft.
K. M. Hunt and H. R. Adams 1 G. O. Kennedy, 4 bbl., Maxton sand, T.D. 1,858 ft.
Glenville district: Pittsburgh & W. Va. 7800 Lester Davis, 280,000 cu. ft. gas, Big Injun 1,838-1,930 ft., gas 1,898-1,909 ft., T.D. 1,944 ft.

Wayne County

Ceredo district: Sinclair Glass Co. 1 Mary E. Brown, drilled deeper, start 2,428 ft., Corniferous lime 2,408-2,845 ft., poison gas 2,500 ft., gas 2,785-2,805 ft., gage 130,000 cu. ft. gas, R.P. 1,020 lb.
Stonewall district: Priddy Oil & Gas Co. 1 Burgess Adkins, surface, 160,000 cu. ft. gas, Big lime 1,111-1,285 ft., Big Injun 1,309-60 ft., Berea 1,873-93 ft., brown shale 2,530-2,862 ft., gas in Big lime and Injun, shot 2,536-2,869 ft., T.D. 2,869 ft.
Union district: Southern W. Va. Oil & Gas Corp. 4 A. W. Preston, 60,000 cu. ft. gas, Big lime 1,095-1,248 ft., Big Injun 1,248-1,355 ft., Berea 1,890-1,900 ft., brown shale 2,510-2,850 ft., gas 2,520 and 2,525 ft., T.D. 2,856 ft.

Wetzel County

Proctor district: S. J. Brendel et al 1 Henry Hohman, 5,500,000 cu. ft. gas, Pittsburgh coal 905 ft., Gordon sand 2,924 ft., T.D. 2,924 ft. This well is located about 6 mi. E and a little S of the town of Proctor. In the vicinity there have been several other large gas wells in the Gordon sand. This gas pool is just east of a well-defined oil pool.

ORISKANY GAS FIELDS

Kanawha County

Poca district: Columbian Carbon Co. 1 Dhelby T. Jones, 2,282,000 cu. ft. gas before shot, Corniferous lime 4,762 ft., Oriskany sand 4,874 ft., depth 4,926 ft.

Putnam County

Union district: West Virginia Gas Corp. 1 C. F. Hill, top Corniferous lime 5,074 ft., 7-in. casing set 5,091 ft.

Jackson County

Washington district: United Fuel Gas Co. 5005 M. A. Bumgardner, drilling in Oriskany sand at 4,905 ft.

Braxton County

Birch district: Pittsburgh & W. Va. 7819 Troy Nottingham, elev. 969 ft.
Pittsburgh & W. Va. 7836 Ed L. Boggs, elev. 1,089 ft.
Pittsburgh & W. Va. Gas Co. 1 Farmers & Citizens State Bank of Clendenin, elev. 962 ft.
Otter district: Pittsburgh & W. Va. 7805 Ward Perrine, elev. 1,045 ft.
Salt Lick district: Pittsburgh & W. Va. 7806 J. B. Reed, elev. 1,036 ft.

Calhoun County

Sherman district H. B. Scott 1 Tell McDonald and A. Hardman, elev. 1,047.73 ft.

Clay County

Buffalo district: Pittsburgh & W. Va. 7818 Norman Goad, elev. 1,467 ft.

Gilmer County

Troy district: A. E. Ellis 1 Elizabeth, Lulu, and Ernest White, elev. 817 ft.

Jackson County

Ripley district: Columbian Carbon Co. 5 Putnam Co., elev. 924.1 ft.
Columbian Carbon Co. 6 Putnam Co., elev. 996.5 ft.
Washington district: Columbian Carbon Co. 7 Putnam, elev. 824.5 ft.
Columbian Carbon Co. 8 Putnam Co., elev. 710.8 ft.

California Fields

(Continued from Page 167)

of undetermined importance in 2 Lechler in the Oak Canyon field at 6,466 ft. This showing is of special importance because the company had just about decided to abandon the hole at 6,435 ft. a few days previously. The present oil sand which was topped at 6,450 ft. is probably in the lower Modelo and if productive commercially should tend to indicate that this formation might prove productive throughout its thickness in other sections of the area.

In the Del Valle field, R. E. Havenstrite is having considerable difficulty with his development program but should be ready to make a production test in 3 Lincoln within another several days. In the Pico Canyon area, Barnsdall Oil Co. has disposed of a 25 per cent interest in its holdings to Ambassador Petroleum Co. and another 25 per cent to Bandini Petroleum Corp., both subsidiaries of Wilshire Oil Co.

In the Rincon field of Ventura County, Chanslor Canfield Midway Oil Co. has reached a depth of 8,915 ft. in 9-C Hobson, a deep test which the company is drilling high up in the hills back of the tideland area. This is the deepest test drilled at Rincon to date and every indication points to the probability that the company has found something of outstanding importance. If a new deeper productive zone is found, and everything points to this, it will greatly increase the future reserves of Chanslor Canfield Midway Oil Co. If a deeper zone is proved up we may anticipate additional drilling especially along the tideland area as well as a resumption of tideland development out in the ocean by directional drilling.

COASTAL DISTRICT COMPLETIONS

Capitan, Santa Barbara County: Shell 1-32 Covarrubias, 32-5n-30w, pumped 960 bbl., 22.1-gravity, 0.5 per cent cut, T.D. 1,430 ft., perf. 1,300-1,427 ft., completed in Vaqueros oil zone.
Newhall-Potrero, Los Angeles County: Barnsdall 18 R.S.F., 26-4n-17w, flow gas lift 344 bbl., 33.3-gravity, 1.2 per cent cut, 200,000 cu. ft. net formation gas, 30/64-in. bean, pressures 175/400 lb., T.D. 7,575 ft., perf. 7,362-7,403 ft., 7,434-7,573 ft., completed in third Modelo zone of Miocene age.
Barnsdall 19 R.S.F., 27-4n-17w, flowed 1,367 bbl., 35.1-gravity, 1.1 per cent cut, 1,065,000 cu. ft. gas, 29/64-in. bean, pressures 825/950 lb., T.D. 7,095 ft., perf. 6,177-6,369 ft., 6,404-49 ft., 6,479-6,574 ft., 6,829-54 ft., 6,884-7,079 ft., completed in first and second Modelo zones of Miocene age.
Ventura Avenue, Ventura County: Lloyd Corp. 7 Lloyd, 24-3n-12w, flowed 50 bbl., 32.1-gravity, 20 per cent cut, 60,000 cu. ft. gas, 35/64-in. bean, pressures 200/1,400 lb., T.D. 9,160 ft., P.B. 8,667 ft., perf. 8,580-8,650 ft.
Shell 136 Taylor, 30-3s-23w, flowed 582 bbl., 30.6-gravity, 3.1 per cent cut, 812,000 cu. ft. gas, 60/64-in. bean, pressures 500/825 lb., T.D. 7,395 ft., P.B. 7,321 ft., perf. 6,666-7,250 ft., completed in formations of Pliocene age.

COASTAL DISTRICT WILDCATS

Castaic district, Los Angeles County: Barnsdall 1-17-A Honor Rancho, 5-4n-16w, T.D. 4,717 ft. in tight oil sand, temporarily suspended, excellent gas showings since leaving 2,250 ft., will drill second test at once, elev. 1,317 ft.
Barnsdall 1-19-A Honor Rancho, 7-4s-16w, building rig.
Del Valle district, Los Angeles County: Fred Jasper 1 Videagin, 17-4n-17w, drilling 2,230 ft. in sand and shale.
R. E. Havenstrite 1 Vasquez, 21-4n-17w, T.D. 7,134 ft. in gray sand, temporarily suspended, first and second Miocene zones tested wet, located SE of discovery well, elev. 1,102 ft.
Universal Consd. Oil Co. 1 Dennis, 21-4n-17w, rigged up, questionable if well will be drilled, elev. 1,006 ft.
Elwood district, Santa Barbara County: Barnsdall-Richfield 88-11 State, tideland, rigging up rotary-drilling equipment.
Goleta district, Santa Barbara County: Texas 3-A Bishoo, 13-4n-29w, drilling in sandy shale 1,096 ft., elev. 36 ft.
Del Mar Oil Co. 1 Goleta, 11-4n-28w, T.D. 120 ft., technical spud, elev. 160 ft.
Loma Grande district, Monterey County: Loma Grande Oil Co. 1 Corev, 23-24s-10e, drilling 3,464 ft. in shale, elev. 1,500 ft.
Los Flores district, Santa Barbara County: Standard 2 Los Flores, 27-9n-33w, graded road and hauled in rig material, elev. 1,084 ft.
Newhall district, Los Angeles County: Aztec Oil Co. 1 Sanborn, 6-3n-16w, drilling 4,060 ft. in sandy shale, elev. 1,516 ft.
H. T. Purman 1 Needham, 13-3n-16w, graded road and location, expect production around 1,550 ft., elev. 1,681 ft.
Texas 1 Whitnah, 14-3n-16w, drilling 1,872 ft., elev. 1,934 ft., located on major Pico anticline.
Oak Canyon district, Los Angeles County: Western Gulf 2 Lechler, 31-5n-17w, drilling 6,466 ft. in sand and shale, running lower structurally than discovery well, contemplate deep test to lower Modelo, elev. 1,489 ft.
Rincon field, Ventura County: C. C. M. O. Co. 9-C Hobson, 17-3n-24w, drilling in sandy shale 8,896 ft., this deepest well drilled in field to date, has had two zones that might be productive, elev. 49 ft.

By
ROBERT INGRAM

Field Work Reaches Fast Pace at Guthrie and Tecumseh Lake

LOGAN County's 10-week-old Guthrie pool last week had four oil wells, three outposts drilling and locations staked or work started on 12 drilling operations in the proven area of 7-17-1w. Continental Oil Co., one of the backers of the Sunray 1 Donaghue discovery well, had six of the new operations; Sunray Oil Co. had three; W. C. McBride, Inc., operators of the field's first extension completed last week, had two, and the other was announced by Sinclair Prairie Oil Co. The field also had its second pipe line when the Empire Pipe Line Co. (Cities Service) started moving oil from the McBride 1 Eastwood.

Only one of the outposts had passed the markers and it was running about 39 ft. low at the first Wilcox sand. That was North American Oil Co. 1 Belle Hirzel, NE NW SE 18-17-1w, a mile south of production. The well was reported tentatively to have topped the second Wilcox sand—the pay zone for the field—at 5,550 ft. and was coring. Although it was running too low structurally to be a probable producer, the zone had not been tested. In addition, the well had 22 ft. of saturated Misener sand topped at 5,220 ft. and if it fails to extend the Wilcox pay, it may very well open a new horizon in the shallower zone.

Meantime, Big Chief Drilling Co., contractors on the 1 Belle Hirzel, had started work on the 1 Trim, NE NE SE 13-17-2w, ½ mile west of the Belle Hirzel. The third outpost for the field was Thomas N. Berry & Co. 1 Howland, SW SW NW 8-17-1w, ½ mile east of production.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Fields	12	2,951	29,553
Wildcats	2	2,650	10,203
Dry holes: Fields	2	.....	7,699
Wildcats	2	.....	4,747
Total	18	.....	52,202
Recompletions	1	*7	.....

*Million cu. ft. gas.

New Viola Lime Pool Opened Near West Earlsboro Field

On top of the growing activity at the state's two new oil pools came the discovery in midweek of a new Viola lime pool about 5 miles southeast of the Tecumseh Lake pool and west of the growing West Earlsboro pool of the Greater Seminole district. The new field was opened by J. E. Crosbie and Atlantic Refining Co. 1 School land, NE SW 16-9-3, which was showing for an estimated 300 to 500 bbl. of oil a day.

The hole was drilled to the Wilcox sand and then was plugged back to 4,651 ft. and pipe perforated at 1-ft. intervals from 4,580 to 4,620 ft. After being treated with 1,000 gal. of acid, it started flowing into pits and then was shut in for tanks. Magnolia Pipe Line Co. started at once to make connections.

The new discovery, important in itself, heightened prospects in the entire area of northern Pottawatomie County when coupled with the success at Tecumseh Lake. Wildcatters were already increasing their activity in the area, which is consistently one of the best wildcat regions in the state and a number of new tests were announced this week (see below).

Gulf Sets Pipe in First Offset at Tecumseh Lake

Two wells were in the pay sands at the new Tecumseh Lake field this week and two more were only a few days drilling away. Nearest the testing stage was Gulf 1 Dixon, SE NW SW 36-10-3, north of the Hall-Jordan 1 Whitehead discovery well. At week's end, Gulf was running 7-in. casing after pulling the last core at 5,240-45 ft. with sand showing. There were some reports that the sand section did not show favorably, but these reports were either discounted in most quarters or were said to indicate only the usual irregularity found in the district.

At the same time Phillips 1 Luttrell, NW NE NW 1-9-3, south of the discovery, was trying to get a drillstem test after coring to 5,262 ft., but the hole was caving and slowing operations. Hall-Jordan 2 Whitehead, SW SE SW 36-10-3, was drilling at 4,940 ft., and Hall-Jordan 1 Pensoneau, SE SW SW 36-10-3, was drilling at 4,729 ft. Several other locations had been made and work was expected to be under way by the end of this week.

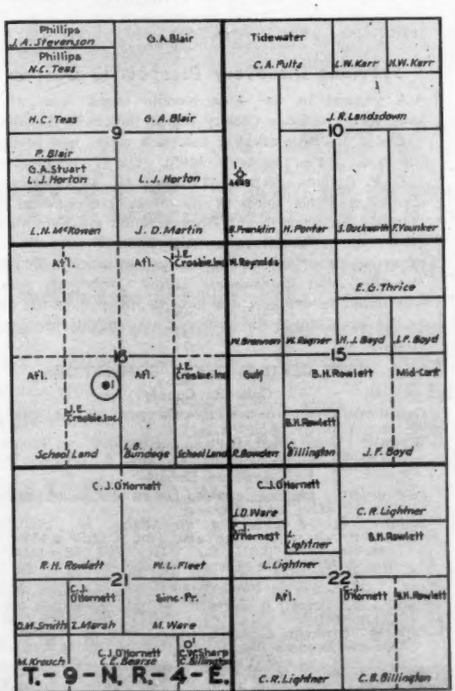
West of the proven area, M. T. Myers 1 Johnson-Utter, NE SE NE 34-10-3, had completed cellar and pits, and E. L. Lippert 1 Rosebush, NE SE SW 34-10-3, was drilling.

Discovery of the pool had opened the entire area, which is just west of the present production in the Greater Seminole district, for wildcatting and exploration. The Shawnee Indian Agency drew an unusually large crowd of buyers at its lease sale early in the week and was paid $264.49 an acre for 76.06 acres nearly a mile northeast of the field by Phillips Petroleum Co. Also, members of the Pottawatomie Indian tribe announced that they would seek to clear title to this and other acreage totaling more than 240 acres. The tribe asserted the land had been leased and not sold to the federal Government and therefore still belonged to the tribe. Other buyers were J. W. McNulty and Magnolia Petroleum Co.

DISCOVERIES GAGED

McBride 1 Eastwood, NE NW SW 7-17-1w, flowed 643 bbl. in 6 hr. and 421 bbl. in next 4 hr., potential 2,484 bbl., bottom-hole pressure 2,200 lb., second Wilcox 5,449-56 ft., 7-in. 5,447 ft., Logan County, extension to Guthrie pool.

Gardner 2 Lowry, N½ SE SW 12-19-1w, flowed 166 bbl. oil and 1,500,000 cu. ft. gas, Misener 4,270 ft., shot 4,737-47 ft., T.D. 4,747 ft., Payne County, outpost near abandoned producer.



Midcontinent Map Co., Tulsa

A new Viola lime pool was opened last week by J. E. Crosbie and Atlantic 1 School Land, circled above in NE SW 16-9-4, Pottawatomie County, in one of the most active wildcat areas of the state

WILDCATS PLUGGED

30-4-9, NE NE NW ..... Pope 1-A Manahan Dry, T.D. 3,003 ft., Gilcrease 2,540-2,615 ft., no show, Hughes County.

18-7-8, SE NW NW ..... Stephens 1 Ferguson Dry, T.D. 1,744 ft., sand 1,365 ft. and 1,520 ft., no show, Seminole County.

AVERAGE DAILY PRODUCTION
LEADING OKLAHOMA FIELDS

	May 17
Allen	4,750
Billings	6,200
Burbank	7,775
South Burbank	7,625
Balance Osage	17,350
Blackwell district	3,675
Bristow-Slick	6,450
Chandler	950
Crescent	1,850
East Cromwell	3,250
Cromwell	2,925
Cumberland	6,500
Cushing-Shamrock	9,100
Dill	6,200
Duncan	3,525
Edmond	3,500
Fish	2,950
Fitts	12,750
Jesse	2,025
Graham-Fox	2,250
Healdton	8,525
Hewitt	9,750
Keokuk	2,775
Konawa	1,075
Lucien	5,750
Moore	975
Northeastern counties	17,250
Oklahoma City	88,100
Olympic	1,750
Ramsey	3,750
Sasakwa	1,275
Sholem-Alechem	2,450
Seminole district:	
Bowlegs	6,275
Carr City	2,200
Dora	1,300
Earlsboro	4,025
East Earlsboro	1,725
South Earlsboro	450
Little River	6,275
East Little River	650
Mission	1,375
Seminole	6,500
East Seminole	950
Searight	1,800
Total Seminole	33,525
St. Louis-Pearson	19,775
Tatums-Tussy	5,425
Tonkawa-Garber-Thomas	3,625
Wewoka	1,650
Yale-Jennings	3,375
Total Oklahoma	415,400

FIELD DRILLING COMPLETED

Altus, Jackson County: Pierce 5 Hardcastle, NW SE SW 15-1-20w, pumped 20 bbl. oil and 3 bbl. water in 14 hr., 7-in. 1,391 ft., T.D. 1,648 ft.

Burbank, Osage County: Sinclair Prairie 11 Osage, W½ SW SE 9-25-6, salt-water disposal, T.D. 2,125 ft.

Bruce, Creek County: Jackson 1 fee, SE SW NW 3-17-9, pumped 5 bbl., Prue 2,078-96 ft., shot 2,079-94 ft.

Clearview, Okfuskee County: Wells 2-A Fish, NE NW SE 25-10-11, old well drilled deeper from 2,170 ft. to T.D. 3,020 ft., sand 2,570-75 ft., some show oil, Gilcrease 2,684-90 ft., 7,000,000 cu. ft. gas.

East Earlsboro, Seminole County: Amerada 1 Miller, N½ SE SE 25-9-5, dry, T.D. 4,297 ft., P.B. 3,105 ft., Wilcox 4,256-62 ft., swabbed 9 bbl. oil and 28 bbl. water in 20 hr.

Fish, Seminole County: Mid-Continent 5 Ferguson, SW SW SW 18-7-8, pumped 100 bbl. oil and 18 bbl. water, lower Calvin 1,498 ft., 8-in. 1,497 ft., T.D. 1,516 ft., shot 1,502-16 ft.

West Hewitt, Carter County: Daube 5 Daube, SW NW SW 17-4s-2w, flowed 154 bbl. through 5/8-in. choke on 2-in. tubing, T.D. 2,266 ft., 7-in. 2,232 ft.

Neustadt 5 Choate, SE NW SE 18-4s-2w, flowed 408 bbl., sand 2,126-59 ft., T.D., 7-in. 2,122 ft., 5-in. 2,070 ft.

Batson 9 Williams, C E½ 20-4s-2w, pumped 35 bbl., sand 1,755-1,800 ft., T.D. 2,632 ft., P.B. 2,130 ft., 7-in. 2,070 ft.

Dixon 7 Woodworth, SW NE NW 20-4s-2w, flowed 297½ bbl. in 14 hr., 2½-in. tubing with packer set at 1,972 ft., 7-in. 2,130 ft., T.D. 2,155 ft.

Gibson 3 Herrell-A, NW SW NW 20-4s-2w, flowed 185 bbl. in 4 hr. through 1-in. choke, 290,025 cu. ft. gas, sand 1,970-2,045 ft., sand 2,063-85 ft., sandy shale 2,095-2,108 ft., sand 2,108-70 ft., limestone 2,180-2,251 ft., T.D., 7-in. 2,246 ft., perf. 1,974-2,170 ft.

Hobart, Kiowa County: Argo 3 Ratliff, NE NE NE 19-7-17w, pumped 154 bbl. in 11 hr., limestone 1,020-1,144 ft., 8-in. 1,005 ft., T.D. 1,144 ft.

(Continued on Page 195)

NORTH CENTRAL TEXAS

Coleman, Eastland Gas Fields Opened; Oil in Callahan Co.

By
R. MARNE SANFORD

FORT WORTH, Tex., May 19.—Field activity in the West Central Texas district for another week overshadowed that of the North Texas area. There were new gas discoveries recorded in both Coleman and Eastland counties, while a shallow discovery for oil was made in Callahan County and another indicated in Coleman County.

Showing the greatest increase in several weeks was the deep wildcat exploration work throughout the Central Texas area. New starts, projected to the relatively deep horizons of the district, were announced for Taylor, Jones, Brown, Shackelford and Comanche counties.

Gas Discoveries

COLEMAN COUNTY.—States Oil 1 Hudson, located in the NW SW Section 22, Block 2, T.&N.O. Survey, was officially completed to open a new gas reserve for the area. The well gaged 10,060,000 cu. ft. of gas from pay drilled from 3,482-86 ft. Casing is set at 3,325 ft. It has been indicated that further development will start immediately in the area.

SUMMARY OF COMPLETIONS

North Central Texas

	No.	Bbl.	Footage
Oil wells: Hull-Silk	3	208	9,141
K.M.A.	5	892	17,556
Olney	2	10	1,084
Other fields	21	1,597	39,928
Wildcats	1	600	6,131
Dry holes: Olney	3	.....	2,399
Other fields	1	.....	554
Wildcats	6	.....	12,969
Total	42	.....	89,762
Key well: Olney	1	.....	507

West Central Texas

Oil wells: Fields	4	425	12,737
Gas wells: Wildcats	2	*13.1	6,280
Dry holes: Fields	2	.....	4,771
Wildcats	2	.....	8,622
Total	10	.....	32,410

*Million cu. ft.

EASTLAND COUNTY.—Another new gas-producing area was opened in the district, this one in Eastland County and from the Marble Falls lime. Discovery was Arnold Kirk 1 J. W. Adams, Jr., David McFadden Survey, Abstract 370. It was officially completed for 3,020,000 cu. ft. of gas after a 3,000-gal. acid treatment from 2,695 to 2,794 ft., total depth. The well topped the Caddo at 2,457 ft. and the Marble Falls at 2,695 ft. Further development has not yet been indicated for the field.

Oil Discoveries

CALLAHAN COUNTY.—A shallow discovery was gaged on the Callahan and Shackelford County line and in the extreme northern part of Callahan County during the week to open a new shallow area just southeast of the old Diller field. The discovery was Clark & Young 2 Diller Bros., 750 ft. from the south and 150 ft. from the east lines of the NE¼ SE¼ Section 54, L.A.L. Survey. With a total depth of 441 ft., the well drilled a show of oil in sand from 434-36 ft. and found the main pay in 4 ft. of saturated sand from 437-41 ft. It pumped 10 bbl. of oil daily, naturally. The operators are preparing to start their 1 Diller Bros., 300 ft. south of the discovery, immediately.

COLEMAN COUNTY.—Now estimated at about 25 bbl. daily, a wildcat in Coleman County is scheduled for a further treatment of 5,000 gal. of acid this week. It is Brannon & Murray 1 John Norris, James Greenwood Survey 304, 4 miles northeast of Talpa and about 6 miles from production. The test topped oil shows in the Adams Branch lime at 2,572 ft. and drilled to a depth of 2,606 ft. The section was treated with 1,000 gal. of acid and an additional 14 ft. of hole taken to 2,620 ft., present total depth. It is now estimated for 25 to 30 bbl. daily, pumping. The discovery is on a 6,000-acre block geologized by Claude F. Daily, Fort Worth.

New Wildcats

TAYLOR COUNTY.—Tal-Vez Oil 1 E. E. Blanks, 400 ft. out of the northeast corner of a 100-acre lease in Section 20, Block 120, G.C.S.L. Survey, is a new 2,500-ft. wildcat location.

JONES COUNTY.—T. J. Coyne 1 L. E. Clyburn, 1,350 ft. from the west and 852 ft. from the north lines of the tract in Lots 24 and 27, Holt subdivision of the Henry Millard Survey 243, is a location for a 2,000-ft. wildcat.

Also in Jones County Humble Oil & Refining Co. has announced the site for a 3,500-ft. wildcat 3 miles southwest of Noodle in the southwestern part of the county. It is 1 D. O. Huddleston, 467 ft. from the NE cor. Section 33, Block 18, T.&P. Survey, on the 158-acre "C" lease.

BROWN COUNTY.—Claude Campbell 1 J. D. Smith is location for a 1,000-ft. wildcat 330 ft. from the north and west lines of an 80-acre lease in the Saco Manufacturing Co. Survey, about 3 miles northwest of Brooksmith.

SHACKELFORD COUNTY.—R. H. Roark 1 Elliott, C SW¼ SE¼ Section 9, Lunatic Asylum Lands Survey, 6 miles south of Albany, is location for a deep 5,000-ft. exploratory test.

Also in Shackelford County T. F. Morrow has announced location for 1 Dyer, a 1,500-ft. wildcat located 1,050 ft. from the north and 150 ft. from the east lines of Section 73, Block 12, T.&P. Survey.

COMANCHE COUNTY.—W. F. Forson has announced the site for his 1 Sliger, a 3,500-ft. wildcat operation located 750 ft. from the south and west lines of the tract in the John Harrison Survey, Abstract 433.

Previous Discovery Prospect to Deepen

A wildcat in the East Noodle Creek district of southwestern Jones County which indicated the opening of a new Swastika oil field last week, was preparing to deepen as the week closed. It is W. W. Fondren 1 C. P. Hodges, Section 32, Block 18, T.&P. Survey, about 1½ miles south of the Sears area opened by Humble last year. No. 1 Hodges found good shows of oil in the Swastika lime from 2,951-57 ft. and was expected to encounter additional saturation in the Swastika sand immediately below. Only salt water was found in drilling to a total depth of 3,090 ft. and as the week closed the operator was considering deepening.

WEST CENTRAL TEXAS COMPLETIONS

Coleman County

Goldsboro: North-South Oil 9 Newton, 20 bbl., pumping, 1,255-qt. shot, 3,825-97 ft.
Wildcat: States Oil 1 Hudson, 10,060,000 cu. ft. gas, 3,482-86 ft., located Sec. 22, Blk. 2, T.&N.O. Sur.

Eastland County

Carbon: E. L. Pinkston 1-B Morris, 75 bbl., open tubing, 320-qt. shot, 2,544-2,628 ft.
Wildcat: Arnold Kirk 1 J. W. Adams, Jr., 3,020,000 cu. ft. gas, 3,000 gal. acid, top Caddo 2,457 ft., Marble Falls 2,695 ft., T.D. 2,794 ft., located David McFadden Sur., Abst. 370.

Jones County

Reid: J. E. Farrell 6 Mareska, 30 bbl., 1,500 gal. acid, 2,570-84 ft.
Wildcat: Groover & Rose and Jones & Stasney 1 Owens, Sec. 46, Blk. 15, T.&P. Sur., dry at 2,383 ft.

Palo Pinto County

Pickwick: States Oil 6 Allen & Ritchie, dry at 2,341 ft.

Shackelford County

Loving: Wittmer Oil & Gas 2 Compton, 602 bbl. daily, 14/64-in. choke, 3,000 gal. acid, est. 300 bbl. daily, 3,611-28 ft.

Stonewall County

Wildcat: Shell 1 Rutherford, Sec. 144, Blk. 1, H.&T.C. Sur., top Strawn 5,167 ft., Mississippian 6,013 ft., Ellenburger 6,197 ft., dry at 6,239 ft. in dolomite

Taylor County

View: S. & B. Oil 1 Speed, dry at 2,430 ft.

(For drilling reports see Page 190)

NORTHERN TEXAS

WICHITA FALLS, Tex., May 19.—A new Ellenburger lime discovery well in Clay County, together with an increase in drilling activity in the K.M.A. Ellenburger field of Wichita County, led the activities of the week in the North Texas district.

The Clay County discovery was Gulf 1 Scaling, Section 3, T.&N.O. Survey, a deep test in the old 3,900-ft. Worsham field of southeastern Clay County. On latest test the well made 174 bbl. of oil and 174 bbl. of water daily. Hole is bottomed at 5,814 ft. in the Ellenburger lime with pipe set at 5,600 ft. on the top of the Caddo lime. With the Ellenburger zone topped at 5,782 ft., it is not definitely known from which horizon the oil is coming, there being 214 ft. of open hole below the casing. It is believed the oil is coming from the Ellenburger lime or from the detrital zone immediately above. Operators were preparing to set liner for recompletion of the well.

K.M.A. Ellenburger

The K.M.A. field's deep 4,400-ft. pay (Ellenburger lime) is due a great deal of drilling during the early summer months as a result of 10 new locations the past week. There are now some 10 completed wells in the deep pay and approximately 24 standing locations staked but not yet actively started. About seven wells are in some stage of drilling.

A recent completion, the largest yet to be completed in the deep lime, was Fain-McGaha Oil 4-B Griffin, W. H. Spillers Survey. It topped the Ellenburger at 4,314 ft. and drilled saturation from 4,320-32 ft., total depth. After plug was drilled from casing set at 4,314 ft., the well kicked off to flow 1,080 bbl. of oil in 9 hours through open casing and then flowed 850 bbl. in the following 6 hours. Final completion gage showed 291 bbl. flowing in 3 hours or at the rate of 2,328 bbl. daily.

Young County Still Active

Young County's new Mississippian lime discovery was gaged some 3 weeks ago and the entire northern part of the county is active with several new deep operations announced.

The discovery was Burns 1-A Larrimore, south of Olney, which was gaged as a large producer to open the Mississippian lime play. There are some five deep operations now preparing to start in the general vicinity of the strike.

Northeast of the discovery Shell 1 J. M. Bloodworth, a 6,000-ft. test, is located 1,825 ft. from the east and 467 ft. from the south lines of Block 151, T.E.&L. Survey.

King Oil 9 J. B. Daniels, another 6,000-ft. wildcat, is in the SE cor. of Section 164, T.E.&L. Survey, ½ mile west and slightly north of the Burns discovery.

Ray Brothers of Dallas and Consolidated Oil 1 J. P. Dunigan, a 6,000-ft. location, is 467 ft. from the south and east lines of Section 163, T.E.&L. Survey, 1 mile northwest of the strike.

L. T. Burns, the discoverer of the field, has located 1 J. R. Jackson in the SE cor. of Block 18-E, I. Holeman Survey, about 7 miles northwest of the discovery.

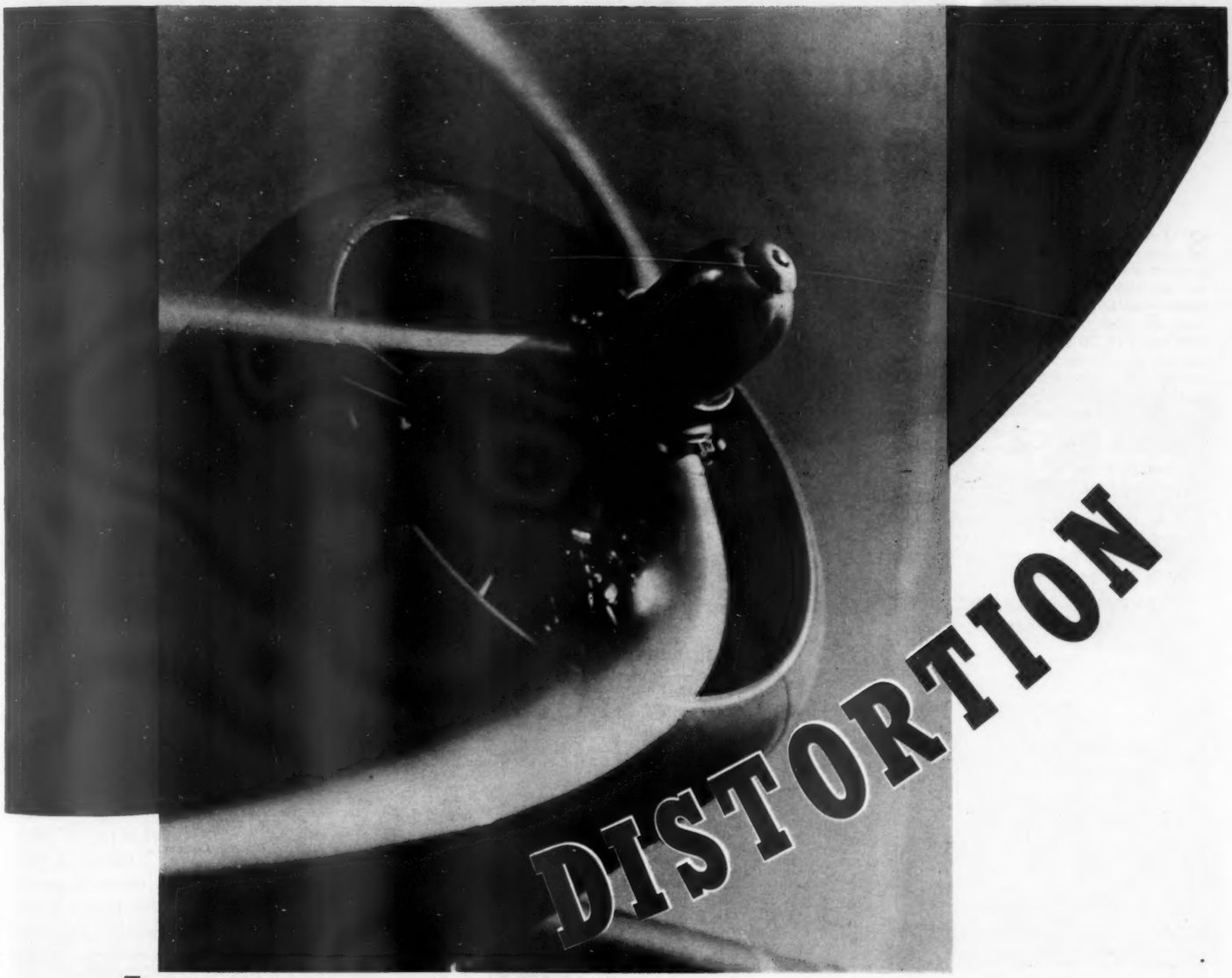
T. D. Humphrey, Dallas, has located 1 E. G. Williamson, in the NE cor. of Block 601, T.E.&L. Survey, about 3 miles southwest of Jean and a similar distance northeast of the north extension area of the 3,900-ft. James field.

NORTH TEXAS COMPLETIONS

Archer County

Hull-Silk: L. T. Burns 104 White, 42 bbl. in 3 hr., ½-

(Continued on Page 190)



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DALLAS, TEXAS

By

ROBERT INGRAM

Outlets Assured for Crude as Operations Reach 400

SUCCESS of field operations (up to a new high of some 400) continued to point to the strengthening position of Kansas as a producing center and last week the one dark spot in the future—limited pipe-line capacity—was brightened by the announcement that at least one trunk line will be enlarged during the summer. With the daily average production for the state running close to the 218,000-bbl. allowable set for May by the state Corporation Commission and purchasers seeking more and more connections, observers have been expressing concern over the 235,000-bbl. pipe-line capacity. Last week Kaw Pipe Line Co., which serves western Kansas, was making plans to loop its main line near Lyons to handle the increased demand.

Meantime new producing areas were opened near Big Creek in Russell County, and near the Silica pool in Barton County. Vickers Petroleum Co. 1 Herr estate, N½ NW SE 24-19-11w, a mile north of the Silica pool, made 50 bbl. of oil swabbing from the Arbuckle dolomite at 3,325½ ft.

AVERAGE DAILY PRODUCTION

LEADING KANSAS FIELDS

	May 17
Augusta	1,200
Bemis-Shutts	11,850
Bloomer	5,700
Burnett	8,600
Burrton	7,000
Chase	5,350
Elbing	1,050
El Dorado-Towanda	6,950
Ceneseo	5,950
Graber	2,300
Greenwood County	8,700
Hollow-Nikkel	1,400
Keesling	1,100
Lerado	700
Lorraine	1,050
Oxford	700
Rainbow Bend	900
Raymond	800
Ritz-Canton	4,000
Trapp	18,450
Balance Russell County	22,900
Sedgwick County	3,150
Voshell	1,750
Silica	18,100
Wellington	1,100
Wherry	2,750
Zenith	8,550
Others	66,150
Total Kansas	218,200

Since the 1 Herr estate lies about halfway between Silica and Eberhardt, it appeared likely that the two pools would soon be joined. Already Eberhardt appears to be joined to Lanterman, thus moving the limits of the Silica district considerably to the north.

Prospects of a new oil pool in Trego County were blasted when W. M. McKnab et al 1 Krysl, NW NE 1-12-22w, a wildcat 9 miles east of the town of Wakeeney, was given up as a dry hole after it swabbed 11 bbl. of fluid in 18 hours, cut 5 per cent with water. Early in the week the test seemed to have excellent prospects of making a well from the Lansing-Kansas City lime series at 3,846-58 ft.

Lansing production in the Big Creek pool of southern Russell County was extended ½ mile southeast during the week with the completion of Chester & Carlock 1 Mitchell, E½ NE SW 6-15-14w. The well was given a maximum potential of 3,000 bbl. from the Lansing-Kansas City lime at 2,068½ ft.

Arbuckle production was opened in the Stafford pool, discovered last fall in Stafford County by Stanolind Oil & Gas Co. from the Viola lime (see below). There were five other wells in the pool last week producing a total daily average of 268 bbl. from the Viola. Attempts were made to complete the new discovery well in the Viola but when they failed, operators deepened to the Arbuckle.

DISCOVERIES GAGED

Stanolind 4 Charles ..... N½ SW SE 15-24-12w Pumped 20 bbl. an hr., 1 per cent water, 35-gravity, Arbuckle 3,945 ft., T.D. 3,964 ft., acid, new horizon in Stafford pool, Stafford County.

WILDCATS PLUGGED

31-9-17w, W½ NW SE ..... Kerlyn 1 Francis Dry, T.D. 3,630 ft., Arbuckle 3,584-87 ft., Rooks County.

1-12-22w, N½ NW NE ..... McKnab 1 Krysl Dry, T.D. 4,070 ft., Lansing 3,846-58 ft., show oil, Trego County.

9-13-14w, E½ NE NW ..... Central 1 Machin Dry, T.D. 3,285 ft., Arbuckle 3,265 ft., some show oil, Russell County.

11-20-12w, S½ SW NE ..... Fred Steckel 1-A fee Dry, T.D. 3,381 ft., Arbuckle 3,353 ft., some show oil, Barton County.

9-20-13w, W½ NW NW ..... Rine 1 Hart Dry, T.D. 3,524 ft., Arbuckle 3,494 ft., show oil, Barton County.

11-23-12w, N½ NE NW ..... Stanolind 1 Mary Hill B Dry, T.D. 3,707 ft., Viola 3,580-3,600 ft., Stafford County.

35-27-2e, E½ SE SW ..... Aylward 1 Aylward Dry, T.D. 3,324 ft., Arbuckle 3,307 ft., Sedgwick County.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Fields	51	51,920	165,573
Wildcats	1	20	3,964
Dry holes: Wildcats	7	.....	24,921
Total	59	.....	194,458

FIELD DRILLING COMPLETED

Bemis, Ellis County: Cities Service 3-C Collahan, NE SE SE 24-11-17w, 3,000 bbl., Arbuckle, T.D. 3,395 ft.

Big Creek, Russell County: Lario 3 Waudby, W½ NW NE 26-14-15w, 1,954 bbl., Gorham, T.D. 3,172 ft., acid.

Blue Hill, Ellis County: J. J. Hall 8 Oswald, NE SE SW 11-12-16w, 1,634 bbl., Lansing-Kansas City, T.D. 3,155 ft., acid.

Breford, Ellsworth County: Magnolia 6 Andrea, NW SW SW 7-17-10w, 20 bbl., Arbuckle, T.D. 3,367 ft.

Transwestern 4 fee, W½ SE SE 12-17-11w, 45 bbl., Arbuckle, T.D. 3,327 ft.

British American 4 Meyer, NW SE NE 28-23-12w, 3,000 bbl., Arbuckle, T.D. 3,838 ft., acid.

Champlin 2 Burmeister, W½ NE NW 13-17-11w, 1,020 bbl., Arbuckle, T.D. 3,350 ft.

Burnett, Ellis County: Champlin 10-D Hadley, SE SE 17-11-17w, 3,000 bbl., Arbuckle, T.D. 3,418 ft.

Dickey 3 Carmichael, S½ SE NW 17-11-17w, 3,000 bbl., Arbuckle, T.D. 3,365 ft.

Coralena, Russell County: Coralena 3 Bitter, S½ NW NW 16-15-13w, 3,000 bbl., Lansing-Kansas City, T.D. 3,136 ft., acid.

Coralena 2-A Sellens, NE NW NW 17-15-13w, 1,770 bbl., Lansing-Kansas City, T.D. 3,000 ft.

Shields 5 Rogg, E½ NW 9-15-13w, 443 bbl., Lansing-Kansas City, T.D. 3,030 ft.

Couch, Cowley County: Tulsa 1 Howard, SW SE NW 12-30-5e, 314 bbl., Bartlesville, T.D. 2,845 ft.

Cunningham, Pratt County: Skelly 4-A Krehbiel, S½ SW SE 24-27-11w, 338 bbl., Lansing-Kansas City, T.D. 3,519 ft.

Fairfield, Russell County: Isern Brothers 1 Meharg, W½ NE SE 15-16-13w, 276 bbl., Arbuckle, T.D. 3,331 ft.

Graber, McPherson County: Prunty 3-B Jones, S½ NE NE 31-21-1w, 252 bbl., Hunton, T.D. 3,289 ft.

Greenvale, Russell County: Texas 1 Kaufman, N½ NW NW 9-15-12w, 890 bbl., Gorham, T.D. 3,275 ft.

Hall-Gurney, Russell County: Skelly 11 Colliver, SE SW 28-14-13w, 3,000 bbl., Lansing-Kansas City, T.D. 2,965 ft.

Phillips 2 Michel, SE SW NW 3-14-14w, 1,171 bbl., Gorham, T.D. 3,160 ft.

Hartman-Blair 5-A Gurney, E½ NE NW 23-14-14w, 570 bbl., Lansing-Kansas City, T.D. 3,050 ft., acid.

Darby 3-B Strecker, S½ SW NE 25-14-14w, 270 bbl., Lansing-Kansas City, T.D. 2,995 ft.

Phil-Han 6 Letsch, SE NW NE 34-14-13w, 1,722 bbl., Lansing-Kansas City, T.D. 2,860½ ft.

Kraft, Ellsworth County: Magnolia 1 Grosshardt, N½ NW SW 9-17-11w, 45 bbl., Arbuckle, T.D. 3,300 ft.

Darby 5 Burmeister, W½ SE SE 3-17-11w, 1,154 bbl., Arbuckle, T.D. 3,315 ft.

Texas 10 Disque, NW NW SW 3-17-11w, swabbed 48 bbl., Arbuckle, T.D. 3,341 ft.

Texas 4-A Burmeister, E½ NW SW 2-17-11w, 762 bbl., Arbuckle, T.D. 3,323 ft.

Laton, Rooks County: Cities Service 1 Reece, CSL SE SE 3-9-16w, pumped 324 bbl., Kansas City, T.D. 3,174 ft., acid.

Broadview A-3 Baxter, CSL SW NW 2-9-16w, swab 94 bbl., Kansas City 3,190 ft., acid.

Broadview 4 Beardmore, CNL SW SW 2-9-16w, pumped 175 bbl., Kansas City 3,210 ft., acid.

Broadview 5 Beardmore, CSL NW SW 2-9-16w, swab 65 bbl., Kansas City, T.D. 3,190 ft.

Broadview A-2 Baxter, CNL NE SW 2-9-16w, pumped 97 bbl., Kansas City, T.D. 3,222 ft., acid.

Lost Springs, Marion County: Mendenhall & Atemus 2 Bucher, SW NW NW 28-17-4w, pumped 48 bbl., chat, T.D. 2,426 ft.

Prussa, Barton County: Shell 2 Harzman, NE SE NW 33-16-11w, swab 61 bbl., Arbuckle, T.D. 3,352 ft.

Ray, Phillips County: Cities Service 1-B Ray, SW SE NW 32-5-20w, pumped 292 bbl., Reagan, T.D. 3,592 ft.

St. John, Stafford County: Cities Service 4 Benton, CNL NW SW 23-24-13w, 3,000 bbl., Arbuckle, T.D. 4,110 ft., acid.

Roxbury, McPherson County: T. C. Johnson 1 Bloomquist, CWL NE SE 19-17-1w, pumped 32 bbl., chat, T.D. 2,706 ft.

Raymond, Rice County: Guif 1-B Hirsh, CEL NE NE 19-20-10w, Lansing, 3,000 bbl., Lansing, T.D. 3,325 ft., acid.

Shutts, Ellis County: Phillips 3 Horn, 5-12-17w, pumped 54 bbl., Arbuckle, T.D. 3,675 ft.

Silica, Barton County: Vickers 1 Herr, CNL NW SE 24-19-11w, swab 50 bbl., Arbuckle, T.D. 3,325 ft.

Stanolind 7 Rose, CWL SW NE 3-20-11w, pumped 81 bbl., Arbuckle.

South Silica, Barton: W. N. Bartlett 1 Weber, CWL SW NW 19-20-11w, swab 120 bbl., Arbuckle, T.D. 3,288 ft., acid.

Gulf 4 Meyer, C E½ SW SE 13-20-11w, pumped 138 bbl., Arbuckle, T.D. 3,257 ft.

Stafford, Stafford County: Stanolind 4 Charles, CNL SW SE 15-24-12w, 1,098 bbl., Arbuckle, T.D. 3,964 ft.

Stoltenberg, Ellsworth County: Iron Drlg. 1 Siemsen, 1,343 bbl., Arbuckle, T.D. 3,303 ft.

Stumps, Rice County: Aylward 4 Habiger, C N½ N½ NE 5-18-10w, swab 61 bbl., Arbuckle, T.D. 3,242 ft.

Trapp, Barton County: Shell 3-C Bitter, NE NE SW 5-16-13w, 3,000 bbl., Arbuckle, T.D. 3,368 ft.

Phillips 9 Bitter, C NW NE 6-16-13w, swab 46 bbl., Arbuckle, T.D. 3,364 ft.

Shell 15-B Bitter, NW NW SE 5-16-13w, pumped 134 bbl., Arbuckle, T.D. 3,358 ft.

W. Trapp, Russell County: Derby 1 Maier, CWL SW SE 10-15-14w, pumped 502 bbl., Arbuckle, T.D. 3,211 ft., acid.

Vaughn, Russell County: Cities Service 6 Vaughn, CEL W½ SW 17-14-14w, pumped 661 bbl., Kansas City, T.D. 3,266 ft., acid.

Zenith, Stafford County: Landon 2 Equitable Life, CWL NE NE 15-24-11w, 2,757 bbl., Misener, T.D. 3,825 ft., acid.

WILDCATS DRILLING

26-5-22w, N½ NW NE ..... Shaffer et al 1 Van Mayer First report, Norton County.

6-7-21w, SE SE NE ..... Palm-King 1 Billips First report, Graham County.

3-14-21e, NW NE NW ..... Meinholdt & Edwards 1 Staley S.D. 1,864 ft., 5-in. 1,750 ft., Johnson County.

15-14-12w, NE NE NW ..... Cities Service 1 Beisel Drilling 205 ft., Russell County.

29-15-8w, SW SW ..... Ingling 1-A State First report, Ellsworth County.

29-15-12w, W½ NW NE ..... Central 1 Steinlie First report, Russell County.

5-16-1w, N½ SW SE ..... Stanolind 1 Karber Drilling 1,587 ft., Saline County.

5-16-11w, S½ SW NW ..... Black-Marshall 1 Redetzke First report, Barton County.

17-18-6w, SW SE SW ..... Continental 1 Taylor Lansing 2,797 ft., Mississippi lime 3,298 ft., T.D. 3,318 ft., electrical log, show oil 3,298-3,318 ft., 7-in. 3,300 ft., Rice County.

33-19-17w, E½ NE SW ..... Magnolia 1 Conrad Anhydrite 1,320 ft., drilling 3,662 ft., Rush County.

9-21-3e, NE NE SE ..... Basinger 1 Janssen Drilling 50 ft., Marion County.

8-21-8w, NW NW NE ..... Herndon 1 Timbers Old well plugged back from 3,522 ft., first report, Rice County.

34-21-18w, N½ SW NW ..... Gulf 1 Seymore Drilling 3,040 ft., Pawnee County.

8-22-1w, E½ NE NE ..... Winkler-Koch 1 Kaufman Base Mississippi lime 3,300 ft., cored shale and sand 3,340-50 ft., Misener 3,349-50 ft. with show oil, cored shale, sand and lime 3,351-58 ft., no show, Hunton 3,353 ft., drilling 3,470 ft., Harvey County.

25-25-2e, W½ NW SW ..... Carlock 1 Whitson Drilling 1,551 ft., Sedgwick County.

18-26-11w, W½ SW NW ..... Reeves 1 Stark T.D. 4,339 ft. in Arbuckle, gages 11,960,000 cu. ft. gas with 2.9 gal. oil per 1,000 cu. ft., gravity gas 0.714, Pratt County.

18-27-13w, W½ SW SW ..... Aladdin 1 Reschke Lansing 3,909 ft., drilling 4,178 ft., Pratt County.

26-28-6e, NE SW NE ..... Rex & Morris 1-A Lucas Underreaming 8-in. 2,272 ft., Butler County.

12-28-11e, SE SW SW ..... Barker 1-A Doue Drilling 800 ft., Greenwood County.

36-32-3e, NE NE NE ..... Shell 1 Hall Layton 2,586 ft., Kansas City 2,687 ft., Bartlesville zone 3,144 ft., no sand, drilling 3,229 ft., Cowley County.

35-34-11w, S½ SE SW ..... Pryor & Lockhart 1 Ishmael Topeka 2,940 ft., Lansing 4,050 ft., drilling 4,475 ft., Barber County.

NEBRASKA-MISSOURI

ST. JOSEPH, Mo., May 19.—The Ohio Oil Co. was about to complete 3 Bahr in the Falls City pool and was preparing to drill plug for a Viola lime test at the well drilled jointly with Harry Harper in the same pool. In the Shubert pool, Richardson County, the Black Gold Operating Co. drilled in 1 Schaible and had a 300-ft. fillup. The company set pipe in the Hunton at 1 Roy Watkins A and was drilling at 1 Watkins B.

(Continued on Page 195)

Louisiana Gulf Coast

(Continued from Page 167)

completion of this well the company will move the rig about 1 mile southwest of the discovery well in 20-13s-4e where location was made for 1 Anna Fitzsimmons.

GUEYDAN.—Additional development was being started on the south flank of the Gueydan field, Vermilion Parish. Fohs Oil Co. staked location for 1 Joseph Dore, east of Union Sulphur Co. 1 Baker, a producing well in 3-12s-1w, while Pure Oil Co. is moving in material for 8 Alliance Trust Co., a west offset to the company's 7 Alliance, completed recently to extend deep-sand production to the west.

PINE PRAIRIE.—The location scheduled to be drilled on the west flank of Pine Prairie field, Evangeline Parish, by Titanic Oil Co., has been changed to Gail Whitcomb 1 Olga L. Wexler in 37-3s-1w, northwest of C. I. Production Co. 1 Evangeline Land & Mineral Co., completed several weeks ago in the Sparta sand to open deep production on this old salt structure.

BAY MARCHAND.—Offshore from La Fourche Parish in the Gulf of Mexico, and located on the Bay Marchand salt dome, Gulf Refining Co. was preparing to retest 1 State PP following a 15-minute drill-stem test through perforated casing at 2,900-05 ft. which tested a slight blow and recovered 1,560 ft. of salt water and sand. The 2,900-ft. horizon is the lowest of four shallow sand sections that were logged by electrical log. Five and one-half inch casing was cemented for testing after rock salt was topped at 2,969 ft. Total depth of the hole is 3,004 ft.

Delacroix Island

On the Delacroix Island prospect, Plaquemines Parish, Texas 1 State flowed 25 per cent oil and 75 per cent salt water when retested through perforated casing at 8,935-50 ft., and another test was scheduled to be made after cementing off perforations. This well assured the Delta district of another productive area the previous week when it flowed gas and distillate from perforated casing at 8,915-25 ft., and additional tests made in this sand section during the week at 8,925-35 ft. showed the same results.

HAYES PROSPECT.—Gulf 1 Calcasieu National Bank, a wildcat located on the Hayes prospect, Calcasieu Parish, is bottomed at 10,534 ft., and 7-in. casing is scheduled to be cemented on bottom following the running of an electrical log which showed possible production in several sand sections. These sands were logged as follows: 9,892-9,904 ft., 9,912-14 ft., 10,072-76 ft., 10,414-22 ft., and 10,423-32 ft. The Discorbis was topped at 8,811 ft., Heterostegina at 9,367 ft., rounc Marginulina at 9,801 ft., and Marginulina Vaginulina at 10,126 ft. Location is in 18-11s-5w.

ST. GABRIEL.—Shell 1 Gueymard, a south offset to the discovery well of the St. Gabriel field, Iberville Parish, showed promise of opening production from a new sand as 29 bbl. of 26.8-gravity oil was recovered on a 10-minute drill-stem test at 8,615-30 ft. Working pressure built up to 30 lb. Approximately 30 ft. of sand was logged in the section from 8,614-52 ft. The discovery sand is found at intervals from 7,600-7,700 ft.

WEST LAKE VERRET.—In the West Lake Verret field, St. Martin Parish, Shell Oil Co., Inc., opened a shallow sand for the structure when 2-A Norman-Breaux was completed for an initial production of 75 bbl. of 26.8-gravity oil daily flowing through a 10/64-in. choke. Tubing pressure was 670 lb. and casing pressure 950 lb. The well was drilled to a total depth of 2,817 ft., plugged back to 2,372 ft., and was completed with 5½-in. casing cemented at 2,326 ft. This structure is highly faulted which has resulted in several producing horizons being opened, none of which are said to be from the same sand. Other sands are found at 7,400 ft., 7,900 ft., 8,000 ft., 8,400 ft., 8,700 ft., 8,800 ft., and 11,490-97 ft.

LOUISIANA GULF COAST COMPLETIONS

Acadia Parish

North Crowley field: Humble 10 Ohlenforst, 226 bbl., 9/64-in. choke, T.D. 8,748 ft., plugged back, T.D. 8,550 ft.

La Fourche Parish

Bayou Des Allemands field: Amerada 2 J. P. Moore, dry, T.D. 10,702 ft.

Golden Meadow field: Bering 3 Cural, 173 bbl., 10/64-in. choke, perf. casing 5,435-45 ft., T.D. 5,477 ft.

Calcasieu Parish

Edgerly field: Gulf 1 Miller, gas well, perf. casing 6,911-25 ft., T.D. 8,502 ft.

Plaquemines Parish

Grand Bay field: Gulf 13 State, 360 bbl., ½-in. choke, perf. casing 8,110-17 ft., T.D. 8,120 ft.

Quarantine Bay field: Gulf 27 State, 570 bbl., ½-in. choke, perf. casing 8,990-9,004 ft., T.D. 9,010 ft.

St. Landry Parish

Port Barre field: Grubb & Hawkins 4 Watkins, dry, T.D. 5,733 ft.

St. Martin Parish

Anse La Butte field: Glassell & Glassell 1 Fournet, gas well, T.D. 7,551 ft.

Stanolind 1-C Martin, 209 bbl., 19 hr., ½-in. choke, T.D. 4,775 ft.

St. Mary Parish

Charenton field: Pan American 23 Laws Realty, 50 bbl., 12/64-in. choke, top sand 1,125 ft., T.D. 1,135 ft.

West Cote Blanche field: Texas 6 West Cote Blanche, 405 bbl., 10/64-in. choke, perf. casing 7,400-24 ft., T.D. 7,854 ft.

Wildcat: Baldwin Minerals 1 Adeline Sugar, dry, T.D. 2,640 ft.

St. Tammany Parish

Wildcat: W. T. Burton 6 State, dry, T.D. 9,191 ft.

Vermilion Parish

Gueydan field: Pure 7 Alliance Trust Co., 330 bbl., 12/64-in. choke, perf. casing 9,782-30 ft., T.D. 9,841 ft.

LOUISIANA GULF COAST DRILLING REPORT

Beauregard Parish

Atlantic 1-D Rice Land & Lumber Co., south of Neale field, 30-4s-10w, drilling sandy shale 5,468 ft.

Humble 1-B Edgewood Land & Logging Co., 25-6s-10w, drilling sandy lime 4,780 ft.

Iberia Parish

Gulf 1 Petit Anse Co., Aver Island salt dome, 59-13s-6e, T.D. 9,545 ft., D.S. stem stuck at 5,400 ft.

Rapides Parish

Chamblee & Pitts 1 Lee Lumber Co., 6-5n-3e, 10⅞-in. casing 553 ft.

St. Mary Parish

William Helis 1 Avoca Inc., Avoca Island prospect, 45-15s-13e, drilling shale 9,787 ft.

Terrebonne Parish

Gulf 1 Picou, Lapyrouse prospect, 70-20s-18e, T.D. 10,759 ft., running electrical log.

Barnsdall 1 State Point Au Fer prospect, drilling shale 9,890 ft.

Vermilion Parish

Cities Service 1 Homeseeker Land Co., 11-11s-1e, drilling shale 10,327 ft.

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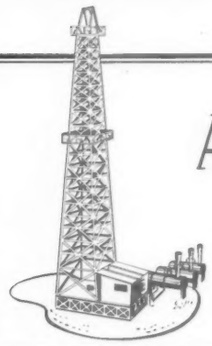

Among the Drilling

REX Drilling Co., Oklahoma City, Okla., has announced location for 1 Billington, NW SE SE 21-9-4, 1¼ miles south of the latest Pottawatomie County, Oklahoma, discovery which opened production this week from a new Viola lime pool.

BIG CHIEF Drilling Co., Oklahoma City, Okla., is drilling a number of wells in western Oklahoma City in addition to the wildcat south of the new Guthrie pool. Among them are 1 Cook, on the northwest flank of the Oklahoma City Wilcox zone and the 1 McManus, south of the 1 Cook.

PLUMMER Drilling Co., Houston, Tex., has discovered a new producing sand in the Coletta Creek field in Victoria County, Texas, which correlates roughly with the producing zones in the Cologne and Victoria fields. Screen was set in the Plummer well at about 4,800 ft. and the well cleaned itself under 2,500-lb. pressure.

THOMPSON Drilling Co., Centralia, Ill., is testing a possible pool discovery well near Eldorado in NW NE SE 17-8s-7e, Saline County, Illinois. The operation is on the Otis Carter farm. Oil showing was found in the Tar Springs at about 2,242 ft.

RICHMOND Drilling Co. is moving rig to a farmout lease obtained from Shell Oil Co., Inc., between the Maljamar and Vacuum pools in Lea County, New Mexico. Location for Richmond 1 Shell-State is in 22-17s-33e.

M. E. BOLLES, of Pinoak, Pa., is operating a friction-drive rig for Ohio Oil Co. on Carnegie-Illinois corporation lands in Springfield Township, Erie County, Pennsylvania, where shallow-gas production is obtained at about 500 ft.

H. E. WILLIAMS, Houston, Tex., is moving a rig to Chambers County, Texas Gulf Coast, where an 8,000-ft. wildcat will be drilled for R. Montgomery et al in the Trinity Rice Disposal Co. lease in Section 45, T.&N.O. Survey. In Brazoria County, Texas, material is being moved about 1 mile north of the Lochridge field for 1 Houston Land & Trust Co., which is being drilled jointly with John Mayo.

TISSUE Drilling Co., Houston, Tex., is moving rig to location for T. J. Wood et al 1 Otto Scheneman, a wildcat location in the Daniel Harman Survey, 3 miles north of the Bammel field in Harris County, Texas. Contract calls for drilling to 6,500 ft.

JACK FRAZIER, Houston, Tex., is scheduled to move a rotary to Orange County, Texas Gulf Coast, for an 8,500-ft. wildcat located on the Carrie Brown lease about 4½ miles south of Orange. The well is being drilled jointly with Earl Hankamer.

GRADY VAUGHN, drilling contractor of Dallas, Tex., is drilling the McAlester Fuel Co. 1 Franks, which has tested oil in the Cotton Valley formation and is being carried to the Smackover lime. The wildcat is located 5 miles east of the Dorcheat field, Columbia County, Arkansas, and may open a new field or an important extension to Dorcheat.

H. I. MORGAN, Shreveport, La., drilling contractor, is moving a heavy rig from Stone County, Mississippi, to Clarke County, Alabama, to drill the Union Producing Co. 1 Waite, an important deep wildcat located on the Hatchitigbee anticline near Bladen Springs.

MORRIS & HAMILTON Drilling Co., Houston, Tex., opened the first commercial crude production in the Garwood area, Colorado County,

Walton L. Clingman, tool pusher for Fain Drilling Co., Oklahoma City, Okla., and A. T. "Rab" Slagle, driller, on the derrick floor of Fain's rig No. 7, drilling at Continental Oil Co. 1 Donahue near Guthrie, Okla.

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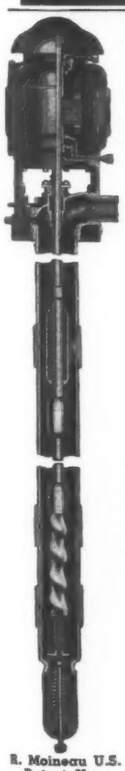

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Texas, with the completion of W. R. Davis Co., Inc., 1-B Brownston. The test is producing at the rate of 320 bbl. of pipe-line oil per day through a $\frac{7}{16}$-in. choke from the Cockfield sand at 6,100 ft. The completion ended a 12-year search for oil in this area in which several gas-distillate wells and dry holes had been drilled. The rig is being moved to a new location offsetting the new producer. In the Lakeview area, Wharton County, Texas, the 1 Hartman being drilled for the same company is expected to be completed for a gas or distillate producer in a 3,400-ft. sand. Two other rotaries are running for the same company in the south part of the Rincon field, Starr County, Southwest Texas.

BIG WEST Drilling Co. of Dallas, Tex., drilled the British American Oil Producing Co. 1-A Houston estate, a Sharkey County, Mississippi, wildcat which has a show of oil and is testing.

HOUSH & THOMPSON Drilling Co., Houston, Tex., is preparing for another production test at the company's 2 Clary, southeast of the discovery well of the West Conroe gas field, Montgomery County, Texas Gulf Coast. This well showed promise of opening the first crude production in the area as the result of a drill-stem test, but when tested during the week the well showed nothing but dry gas. Other operations are reported in the Eola field of Avoyelles Parish, Louisiana, for Gulf Refining Co., and at the Raceland gield, La Fourche Parish, for Harry Fotiades.

ROWAN Drilling Co., Houston, Tex., is moving a rotary to Liberty County, Texas, where an 8,500-ft. wildcat will be drilled on the H. B. Willis lease in what is known as the Felicia prospect, southwest of Nome. The well will be drilled jointly with Hebert & Smith.

HARRY L. EDWARDS Drilling Co., Houston, Tex., has started drilling operation on 1 C. Schaar, located in the Cologne area, Victoria County, Texas. Other operations are reported in the Old Ocean and Dickinson fields in Brazoria and Galveston counties, Texas Gulf Coast.

ROCKY MOUNTAIN Drilling Co., Los Angeles, Calif., is drilling at about 3,000 ft. in two wells in the Inglewood field of Los Angeles County, California. The wells are the R. R. Bush Oil Co. 1 Smith in 7-2s-14w, and Federal Oil Co. 2 Smith in the same section.

T. P. PIKE Drilling Co., Los Angeles, Calif., last week was making a production test on Southern California Petroleum Corp. 1 Townsite in the Rosecrans field. The well was carried to a total depth of 8,374 ft., plugged back to 8,117 ft. and perforated from 7,964 to 8,117 ft.

Officials and field superintendents of Taylor Drilling Co. at its Centralia, Ill., headquarters: W. R. Gates, tool pusher; Miss Louise Trower, secretary; Ike Taylor, partner in the firm; Mrs. Rose Cook, office manager; Buck Cornelius, tool pusher. Jake Taylor, other partner in the firm, was not present when the picture was taken. The drilling firm has 10 rigs operating in Illinois, Indiana, Nebraska and Iowa

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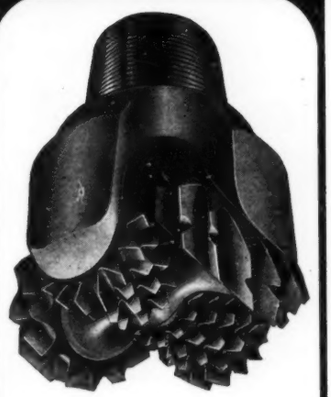

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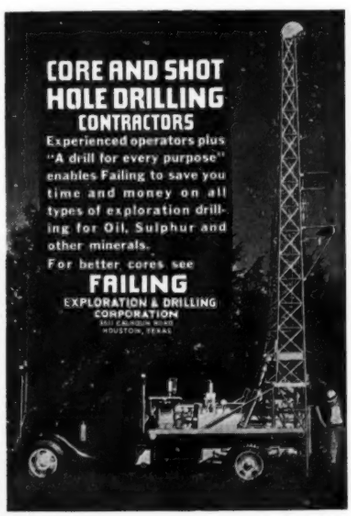

"Tough as an alley cat for wear—
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Deep Drilling Trend Extends Over Entire Basin

By
R. MARNE SANFORD

MIDLAND, Tex., May 19. — Starting in northern Pecos County where several discoveries were recorded more than a year ago, the trend toward deeper horizon exploration has now spread virtually throughout the entire West Texas district. Additional deep discoveries have been recorded in recent months in Pecos County as well as Ward and Crane counties. In the northern part of the Permian basin deep strikes have been recently recorded in Yoakum and Andrews counties. Prospective discoveries below the normal production levels are being tested at several points throughout the entire basin, and during the past week new deep exploratory projects were announced for Upton, Pecos, Andrews and Martin counties, while a deep 11,000-ft. projected test in the Wasson field of Gaines County has resumed drilling below 10,500 ft.

In the southern part of the basin the Simpson and Ellenburger horizons of Ordovician age and the Fusselman limestone of Silurian age are the objectives in the deep tests, while farther north in the basin the lower series of the Permian and in some instances even the Ellenburger lime are the objectives of deep exploratory holes.

Newest deep wildcat for the southern basin was staked by Plymouth Oil Co. as 1 D. L. Alford, located 467 ft. from the northeast and southeast lines of Lot 2, Section 50½, P. B. Scott Survey. The Reagan and Upton county line extends through the east half of the section. The location is 10 miles northwest of the Big Lake field of Reagan County where West Texas' first Ordovician production was obtained some 13 years ago. The wildcat is scheduled to be started immediately and will drill with rotary to 10,000 ft.

Pecos County Wildcats

Two new wildcat tests were staked in Pecos County, one of which is contracted to the Ordovician as an outpost to the Simpson producing Abell field. It is Stanolind 1 Myer-Logan, 638 ft. from the south and 672 ft. from the west lines of Lot 7, Section 31, Block 9, H.&G.N. Survey, ¼ mile north of the company's 1 Conry-Davis, an active 4-mile outpost to the Abell field. The 1 Conry-Davis is located in Section 31, same block and survey as the new test, and missed the Simpson section entirely, going into the detrital zone and then Ellenburger lime from the Permian. It is drilling ahead below 4,965 ft.

A shallow Pecos County wildcat is Allen Hargrave 1 University, 1,055 ft. from the north and 1,680 ft. from the east lines of Section 4, Block 17, University Lands Survey, an 1,800-ft. test which will be drilled with cable tools and will attempt to extend the Taylor-Link field a mile to the southeast.

Deep Crane Wildcat Will Test Silurian

Gulf 1-F University, deep 10,000-ft. wildcat in eastern Crane County which offered indications 2 weeks ago of opening a field below the 10,000-ft. level, from the Ordovician age rocks, will be plugged back for testing in the Silurian section. This is the zone which has yielded two large wells on the south end of the Shipley field in southeastern Ward County. Some shows of oil were found in the Silurian section at the 1-F University from 9,405 ft. to 9,425 ft., however, as the week closed the hole had been cemented back only 170 ft. or from an old total depth of 10,658 ft. to 10,488 ft. It is believed that attempts are still being made to shut off the sulfur water flow in the deep zone before finally plugging back up the hole to test other shows. Last test prior to plugging back netted 134 bbl. of sulfur water in 24 hours, swabbing, with no oil showing.

North Ector Deep Strike Indicated

Deep production for the North Goldsmith field of northwestern Ector County was seen as a possibility at the Grisham & Delaney 1 R. B. Cowden, Section 4, Block 45, Township 1n, T.&P. Survey, ¼-mile south outpost to the regular producing area of the field. The well reported a swabbing gage of 9 bbl. hourly through tubing. The hole is bottomed at 6,431 ft., about 2,000-ft. below the regular level of the area, and tubing is set at total depth with perforations opposite the oil section at 6,405 ft. Testing was still under way as the week closed.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Southern West Texas			
Oil wells: Johnson	3	1,821	12,519
Jordan	2	2,885	7,198
North Cowden	2	823	8,852
White & Baker	3	161	6,315
Other fields	12	10,659	37,859
Dry holes: Fields	2	.....	5,189
Wildcats	1	.....	3,045
Total	25	.....	80,977
Northern West Texas			
Oil wells: Slaughter	14	16,126	70,080
Wasson	5	4,240	25,925
Total	19	.....	96,005
Southeast New Mexico			
Oil wells: Maljamar district	3	837	12,165
Other fields	2	650	5,273
Total	5	.....	17,438
Texas Panhandle			
Oil wells: Carson County	1	90	3,172
Gray County	3	441	9,852
Hutchinson County	8	2,299	24,477
Wheeler County	1	207	2,138
Gas wells: Moore County	1	*10.6	3,060
Total	14	.....	42,699

*Million cu. ft.

SOUTHERN WEST TEXAS COMPLETIONS

(24-hr. ratings based on last 3 hr. of 6-hr. gage)

Crane County

Waddell field: Gulf 21 Waddell, 5,001 bbl., open casing, 5,000 gal. acid, 4,467-5,478 ft.
Dunes field: Magnolia 22 Hardwicke-University, 116 bbl., pumping, 200-qt. shot, 3,075-3,136 ft.

Ector County

Goldsmith field: Gulf 348 Goldsmith, 803 bbl., open casing, 63-qt. shot, 4,202-32 ft.
Jordan field: Gulf 7-N State, 1,628 bbl., open tubing, 5,000-gal. acid, 3,554-98 ft.
Snowden & McSweeney 7 University, 1,257 bbl., open tubing, natural, 3,583-3,600 ft.
Foster field: Kewanee Oil 4 Foster, 92 bbl., pumping, 1,170 gal., acid, 3,884-4,145 ft.
Johnson field: George Livermore 2-40 Johnson, 646 bbl., 1½-in. choke, 295-qt. shot, 4,045-4,153 ft.
Sinclair Prairie Oil 7-C Johnson, 1,114 bbl., open casing, 300-qt. shot, 4,081-4,180 ft.
Stanolind 2-B Johnson, 61 bbl., ¼-in. choke, 390-qt. shot, 4,179-86 ft.
North Cowden field: Moran Drlg. 2 Smith, 636 bbl., ¾-in. choke, 300-qt. shot, 4,250-4,402 ft.
Texas 6 Holt, 187 bbl., open tubing, 232-qt. shot, 4,380-4,450 ft.

Pecos County

Pecos Valley field: Brandor Pet. 5 Dorr, 121 bbl., ¾-in. choke, 200-qt. shot, 1,951-2,075 ft.
L. C. McKean 1 Iowa Realty Co., dry at 1,787 ft.
White & Baker field: John Lewis 3 White & Baker, 58 bbl., ¼-in. choke, natural, 2,110-36 ft.
Shasta Oil 5 White & Baker, 34 bbl., open tubing, 80-qt. shot, 2,065-84 ft.
Shasta Oil 6 White & Baker, 69 bbl., 90-qt. shot, 2,070-95 ft.
Tobarg field: Stanolind 22-B Tippett, 72 bbl. oil and 31 bbl. water, pumping, 444-75 ft.
Misc. field: Phillips 1-127 Price, dry at 3,402 ft.

Reagan County

Wildcat: H. Schooler 1 Wolters, NE NE Sec. 51, G.C.& S.F. Sur., top anhydrite 1,185 ft., salt 1,240 ft., Cowden anhydrite 1,445 ft., Yates 1,625 ft., dry at 3,045 ft.

Upton County

McElroy field: Gulf 244 McElroy, 846 bbl., open casing, 890-qt. shot, 2,862-2,962 ft.

Winkler County

O'Brien field: Gulf 155 O'Brien, 127 bbl., ¾-in. choke, 70-qt. shot, 2,885-2,961 ft.
Keystone field: Ralph Lowe 1 Zachary, 424 bbl., open tubing, 540-qt. shot, 3,070-3,274 ft.
S. W. Richardson 2 Jenkins-Southland, 306 bbl., 1-in. choke, 320-qt. shot, 3,354-3,440 ft.
Misc. field: C. V. Lyman 1-A Cowden, 474 bbl., open tubing, natural, 2,740-2,983 ft.

Ward County

North Ward field: West Texas Oil & Realty 8-C University, 2,277 bbl., open casing, 190-qt. shot, 2,625-98 ft.

SOUTHERN WEST TEXAS WILDCAT REPORT

Crane County

Gulf 1-F University, SE SE Sec. 22, Blk. 31, University Sur., top Ellenburger 10,628 ft., T.D. 10,658 ft., P.B. 10,488 ft., to test.

Crockett County

R. H. Henderson 1 Couch, 467 ft. from N and 2,173 ft. from E lines Sec. 37, Blk. GG, H.E.&W.T. Sur., S.D.O. 505 ft.
Zay Kimberlain 1 Robbins, 417 ft. from S and E lines Sec. 4, Blk. W, G.C.&S.F. Sur., location.

Ector County

Cities Service 1 F. C. Addis, SW SE Sec. 34, Blk. 43, Twp. 2s, T.&P. Sur., drilled in new hole to 5,500 ft., P.B. 4,210 ft., pumped 15 bbl. oil and 30 bbl. water in 4 hr.
Forest Development Co. 1-C Edwards, SE SE SW Sec. 20, Blk. 43, Twp. 3s, T.&P. Sur., shot 210 qt. 4,240-4,320 ft., cleaning out.
M. D. O'Quinn 1 TXL, SE NW W½ Sec. 31, Blk. 44, Twp. 3s, T.&P. Sur., location.

Loving County

H. C. McAuley 1 E. Hall, SE Sec. 60, Blk. 7, W.&N.W. Sur., T.D. 4,820 ft., P.B. 4,803 ft., testing water shut-off.
Pinal Dome Oil 1 Michigan Oil fee, NW SW Sec. 15, Blk. 26-C, P.S.L. Sur., 5,300-ft. test, drilling 4,565 ft.

Pecos County

Redmond, Greene & Davis 1 Iowa Trust, E¼ W¼ Sec. 29, Blk. 10, H.&G.N. Sur., Ordovician test, spudding.
O'Quinn 2 O'Neil, S½ Sec. 74, Blk. 10, H.&G.N. Sur., Ordovician test, T.D. 1,300 ft., last report.
Sinclair Prairie 1 Grove, Lot 9, Sec. 26, Blk. 9, H.&G.N. Sur., Ordovician test, drilling 5,000 ft.
A. Hargrove 1 Univer.-Continental, NE cor. Sec. 4, Blk. 7, University Sur., first report.
Phillips 1 Price, SE cor. Sec. 4, Blk. 106, T.&St.L. Sur., 4,000-ft. test, first report.

Reagan County

Amerada 1-RA University, 1,980 ft. from N and 600 ft. from E lines of Sec. 3, Blk. 48, University Sur., Ellenburger lime test, drilling 5,443 ft.
H. Schooler 1 R. A. Wolters, NE NE Sec. 51, G.C.&S.F. Sur., T.D. 3,035 ft., prepare to quit.

Reeves County

C. A. Kitos 1 A. B. Buchard, SW Sec. 7, Blk. 58, P.S.L. Sur., Delaware test, drilling 988 ft.
Roy Johnson 1 Perkins, Sec. 18, Blk. 7-C, P.S.L. Sur., S.D. 3,362 ft.

Schleicher County

Harold H. Opp 1 Jackson, Sec. 41, Blk. LL, T.C. Sur., T.D. 6,155 ft., fishing tools.

Sutton County

S. B. Roberts 1 George Allison, NW NE Sec. 44, Blk. K, G.H.&S.A. Sur., S.D. 740 ft., casing.
Domain 1 G. S. Allison, SW NE Sec. 91, Blk. 9, T.W. N.G. Sur., Ellenburger lime test, S.D. 1,098 ft.

Terrell County

Texas Consolidated Oil 1 Holmes, NE NE Sec. 14, Blk. 2-A, G.H.&S.A. Sur., 3,600-ft. test, 10-in. 1,100 ft., T.D. 1,275 ft., preparing to start up.
H. H. Sides 1 Rose, Sec. 15, Blk. 148, T.&St.L. Sur., T.D. 720 ft., last report.
L. M. Thomasson 3 Bates-Graham, 660 ft. from N and 2,490 ft. from W lines, Sec. 30, Blk. 1, I.&G.N. Sur., drilling 1,376 ft.

Upton County

H. C. Wheeler 1 Kincaid, 2,173 ft. from N, 467 ft. from E lines. Sec. 1, G.C.&S.F. Sur., T.D. 710 ft., last report.
Pittman & Atkins 1 Fowler-Starnes, NW NE Sec. 89, G.C.&S.F. Sur., 3,500-ft. test, S.D. 420 ft.

Ward County

Fitzpatrick & Slack 1 Wilson, Sec. 145, Blk. 34, H.& T.C. Sur., 1½ mi. SE of discovery well, T.D. 5,034 ft., shot 100 qt. 5,023-43 ft., flowing 30 bbl. oil per day.
J. E. Fitzpatrick 1 T. B. Pruit, SW SW Sec. 23, Blk. 1, W.&N.W. Sur., S.D. 140 ft.
Bells Wells 1 Wilson, NW SW Sec. 133, Blk. 34, H.& T.C. Sur., drilling 550 ft.

Winkler County

Magnolia 20 State-Walton, NW cor. Sec. 4, Blk. 3-B, P.S.L. Sur., drilling 3,543 ft.
Sam Weiner 2 Hailey, NW NE Sec. 7, Blk. 11-B, P.S.L. Sur., top brown lime 2,230 ft., top Yates 2,335 ft., drilling 2,650 ft.

NORTHERN WEST TEXAS

Two new deep exploratory wildcats were staked in northern basin counties during the week and another deep 11,000-ft. exploratory hole in the Wasson field

of Gaines County resumed work at 10,500 ft. after a several months' shutdown.

In Martin County, C. E. Hyde of Fort Worth and P. N. Wiggins, Jr., Dallas, announced location for a 5,000-ft. wildcat on a 20,000-acre block lying in southwestern Martin and northern Midland counties. It is 1 M. J. Stimson and E. S. Burley, located 1,320 ft. from the south and west lines of Section 4, Block 38, Township 1s, T.&P. Survey, about 14 miles northwest of the town of Stanton. Contract has been let and materials are being moved to the site. It is in an area where no other wildcats have been drilled. Out of the original block of 20,000 acres, spreads were taken by Texas, Magnolia, Texas Pacific, Seaboard, Union Oil, Shasta Oil, and several large independent operators.

In Andrews County the Mascho Oil Co., Midland, has announced location for its third wildcat, there now being two tests active by the company in the general vicinity. The new operation is 1 Gulf-University, NW cor. Section 19, Block 9, University Survey, 3 miles north of the Emma field and a similar distance south of the Fuhrman field. Contract has been let for a 4,500-ft. hole. It is about 1½ miles northwest of a failure drilled by Rogers & Rogers several years ago which reported porosity and some oil shows. The test is on a tract farmed out from Gulf Oil Corp.

Mascho Oil 1 Texas-University, 1,980 ft. from the north and west lines of Section 11, Block 13, University Survey, is drilling below 1,870 ft.

The firm's other southern Andrews County active test is 1 Fisher, NE SE Section 16, Block 36-A, P.S.L. Survey, southeast of Schafter Lake, which is drilling below 3,545 ft.

11,000-Ft. Test Resumes Work

In the Wasson field of northern Gaines County a deep exploratory test, Amon G. Carter 5-D Wasson, north offset to the operator's deep 6,800-ft. discovery of several months ago, has resumed operations at 10,500 ft. after being shut down for several months. The test is drilling on an 11,000-ft. contract depth and has been drilled as a "tight" operation. The test is located in the NW SE Section 50, Box AX, P.S.L. Survey.

Possibility of a mile east extension for the extreme north end of the Slaughter field's production in Hockley County was seen as the week closed. The test is Magnolia 2 Wilson, Labor 10, League 41, Maverick County School Lands Survey. Cores from 4,901-41 ft. recovered oil-stained lime and at last reports the test was going ahead below 5,035 ft. still in oil-stained lime. It is located a mile east of the company's 1 Wilson which made a small producer 2 weeks ago to extend production a mile in the north direction.

NORTHERN WEST TEXAS COMPLETIONS

Cochran County

Slaughter field: Atlantic 11 Boyd, 1,459 bbl., 2-in. casing outlet, 10,000 gal. acid, 4,950-5,062 ft.
Devonian Oil 2 Boyd, 1,344 bbl., 3-in. casing outlet, 13,200 gal. acid, 5,006-58 ft.
Devonian Oil 6-A Duggan, 792 bbl., open casing, 10,500 gal. acid, 4,946-5,006 ft.
George Livermore 1 Wright, old T.D. 4,997 ft., deepened to 6,621 ft., dry.

Hockley County

Slaughter field: Honolulu Oil 4-A Slaughter, 1,732 bbl., open casing, 7,000 gal. acid, 4,895-4,990 ft.
Honolulu Oil 12-B Slaughter, 1,548 bbl., open casing, 9,000 gal. acid, 4,945-5,025 ft.
Magnolia 2-E Mallett, 1,259 bbl., 3-in. casing outlet, 10,500 gal. acid, 4,980-5,040 ft.
S. W. Richardson 4 Coe, 1,032 bbl., 3-in. casing outlet, 10,000 gal. acid, 4,885-4,975 ft.
S. W. Richardson 9-B Slaughter, 1,272 bbl., 2-in. casing outlet, 10,000 gal. acid, 4,905-95 ft.
S. W. Richardson 10-B Slaughter, 1,377 bbl., 2-in. casing outlet, 10,000 gal. acid, 4,905-96 ft.
S. W. Richardson 12-B Slaughter, 1,449 bbl., 3-in. casing outlet, 7,000 gal. acid, 4,903-95 ft.
S. W. Richardson 13-B Slaughter, 1,104 bbl., 2-in. casing outlet, 10,000 gal. acid, 4,910-95 ft.
S. W. Richardson 25-B Slaughter, 560 bbl., 2-in. casing outlet, 9,500 gal. acid, 4,885-4,963 ft.
Tide Water 2 Pirkle, 508 bbl., open casing, 9,000 gal. acid, 4,810-4,985 ft.
Western States Gasoline 3 Mallett, 690 bbl., 3-in. casing outlet, 11,000 gal. acid, 4,945-95 ft.

Gaines County

Wasson field: Continental and Carter 13-44 Langdon, 878 bbl., open tubing, 7,000 gal. acid, 4,915-5,036 ft.

Yoakum County

Wasson field: Don Danvers 4-B Willard, 889 bbl., open tubing, 10,000 gal. acid, 5,085-5,297 ft.
Honolulu Oil 1 Hargett, 149 bbl., open tubing, 10,000 gal. acid, 5,081-5,202 ft.
Shell 16-B Baumgart, 1,351 bbl., open tubing, 10,000 gal. acid, 4,935-5,190 ft.
Texas Pacific 8 Hall, 973 bbl., 1½-in. choke, 10,000 gal. acid, 4,984-5,200 ft.

(Continued on Page 191)

Michigan Fields

(Continued from Page 170)

ADAMS.—Adams-Arenac interest centered on a deep test with good show in Monroe formation down 4,300 ft. Now only Traverse, around 2,400 ft., and Dundee, around 2,900 ft., are producing. The deep test, Don Rayburn 1 Fox, in Section 21, is ½ mile west of the main field. He reported the hole filled more than 2,000 ft. with oil over a 70-hour period. Obstructions hampered pumping equipment, however, delaying the test. In the Adams field Pure Oil Co. and Rayburn had other tests near the Dundee stage.

BAY COUNTY. — Developments were due momentarily in the state's deepest test as Gulf Refining Co. approached the 7,776-ft. level at which drilling was halted by fire and explosion in its 1 Bateson in Bay County. With special equipment, employed when it became impossible to clean the old hole, drilling this week was below 7,000 ft. Intentions are to drill to 9,000 ft. or lower. In Bay-Monitor a nitro shot gave promise of a commercial producer from Berea sand at 1,510 ft. United Drillers & Producers 2 Kircher is the first well in the area to pump around 50 bbl. a day from the shallow formation.

BUTTERFIELD. — Although Sun Oil Co. 1 Hollister in Butterfield-Missaukee was dry at 1,260 ft., a good show of gas and oil was reported in the Walter Weinz wildcat test in Section 2 of Clam Union Township. Completion was scheduled this week in the Dundee around 3,850 ft.

MONTCALM COUNTY. — In Montcalm County dry holes dampened hopes of extending the Amble pool, while Osceola and Lake County gas tests recently tended to confine the producing area.

PERMITS. — The Winterfield developments put Clare County in the lead in the week's issue of drilling permits by the state Conservation Department. Three permits for tests in Winterfield and one for Hamilton were among the 12 for the state, which increased the year's total to 288. Osceola and Van Buren counties each got two permits. The others are for locations in Tuscola, Allegan, Ottawa and Gratiot.

KAWKAWLIN SPACING. — Until the field is more defined, the oil advisory board last week decided, a proposal to establish 20-acre drilling units in Bay's Kawkawlin district will be kept under advisement. That action was taken as the Conservation Department reappointed to the oil board C. A. Smith, Jr., president of Smith Petroleum Co., Grand Rapids, and Edward F. Clagett, manager of Pure Oil Co. Michigan division, for 3-year terms. P. J. Hoffmaster was reappointed conservation director and by virtue of Michigan law continues as supervisor of wells.

MICHIGAN COMPLETIONS

Allegan County

Dorr Township: W. L. McClanahan 1 Graczyk, NE NW SE 19-4n-12w, dry, T.D. 1,576 ft.
Salem Township: Union Oil Co. 2 Bond, NW SW SE 10-4n-13w, 100 bbl., acid, T.D. 1,606 ft.
Salem Gas & Oil Co. 2 Funk, SW NW NE 14-4n-13w, 15 bbl., acid, T.D. 1,595 ft.

Calhoun County

Newton Township: F. H. Skirvin 1 Hallock, NE SW NW 14-3s-7w, dry, T.D. 1,458 ft.

Clare County

Freeman Township: Turner Petroleum Corp. 1 Wiegert, S½ SW SW 25-18n-6w, dry, T.D. 4,005 ft.
Redding Township: Sun Oil Co. 1-B State, W½ NW NE 5-19n-6w, 50 bbl., acid, T.D. 3,808 ft.
Winterfield Township: Sun Oil Co. 2 Strange, S½ NW SW 36-20n-6w, 1,540 bbl., T.D. 3,767 ft.

Isabella County

Broomfield Township: Bundy Hill Natural Gas Co. 1 Winters, NE NE SE 10-14n-6w, 702,000 cu. ft. natural gas, T.D. 1,345 ft.

Kent County

Walker Township: Smith Petroleum Co. 8 Van Dyke, NE SE NE 5-6n-12w, 1,200,000 cu. ft. natural gas, T.D. 1,181 ft.
Voorhees Drilling Co. 3 McKay, SE NW SW 19-7n-12w, 65 bbl., acid, T.D. 1,930 ft.

Lake County

Pinora Township: Taggart Bros. Co. 13 Baderschneider, C E½ 25-18n-11w, dry, T.D. 1,259 ft.

Missaukee County

Butterfield Township: Sun Oil Co. 1 Hollister, W½ NE SW 12-22n-5w, dry, T.D. 1,260 ft.

Montcalm County

Winfield Township: Daily Crude Oil Co. 1 Buggart, SW NE NW 28-12n-9w, dry, T.D. 3,346 ft.

Ottawa County

Georgetown Township: Fisher-McCall Oil & Gas Co. 3 Mackus, NE SE NW 2-6n-13w, 60 bbl., acid, T.D. 1,781 ft.
Tallmadge Township: Daily Crude Oil Co. 1 Riemersma, NW SW NW 4-7n-13w, dry, T.D. 1,980 ft.
Fisher-McCall Oil & Gas Co. 1 Heyboer, NE NE NW 12-6n-13w, 20 bbl., acid, T.D. 1,856 ft.
F. M. Douglass 1 McKay, NE NE NW 26-7n-13w, 30 bbl., acid, T.D. 1,865 ft.

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More than thirty models of single or double drum Winch tractors and Skid Winches enable you to choose the type and size well servicing unit that fits your particular jobs and locations.

Allis-Chalmers Winch Tractors are built and powered to get to wells fast—Transmission ratios furnished as 15 m.p.h. or 30 m.p.h. road speeds in high are available. Transmissions are tractor type, specially designed for tough oil field use—have tremendous overload factor. All tractors are equipped with heavy duty, low pressure tires—and when desired can be equipped with dual wheels and tires on the rear.

All Fred E. Cooper built, Allis-Chalmers Units have the famous Cooper, patented, air-cooled, self-equalizing brakes on the winch drums. Eight line speeds enable operator to use the fastest and safest speed when pulling. All Allis-Chalmers engines are properly cooled under all working conditions. Impeller type pump moves large volume of water at high velocity through the engine block.

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MODEL	L	E	M	W
Maximum Line Pull	62,000 lbs.	54,700 lbs.	32,600 lbs.	20,666 lbs.
Line Capacity, ½"	39,300 ft.	9,740 ft.	8,200 ft.	5,660 ft.
Torque ft. lbs.	590	400	200	128
Engine	6 cyl., Valve-in-Head	4 cyl. Valve-in-Head	4 cyl. Valve-in-Head	4 cyl., Valve-in-Head
Cubic Inch Displacement	844	563	318	201
Bore and Stroke	5¼"x6½"	5¼"x6½"	4½"x5"	4"x4"
Number Main Bearings	4	3	3	3
Governor	Full Throttling	Full Throttling	Full Throttling	Full Throttling
Transmission	4 speeds forward, 1 reverse	4 speeds forward, 1 reverse	4 speeds forward, 1 reverse	4 speeds forward, 1 reverse
Lubrication	Force Feed	Force Feed	Force Feed	Force Feed
Water Pump Capacity 1 ft. head normal R.P.M.	108 gals. P.M.	71 gals. P.M.	35 gals. P.M.	23.9 gals. P.M.

Allis-Chalmers standardized Models E, M, and W Winch Tractors and Skid Winches are available with telescoping masts. Spudding equipment is available for Models L, E, and M. Double drums are available on all models.

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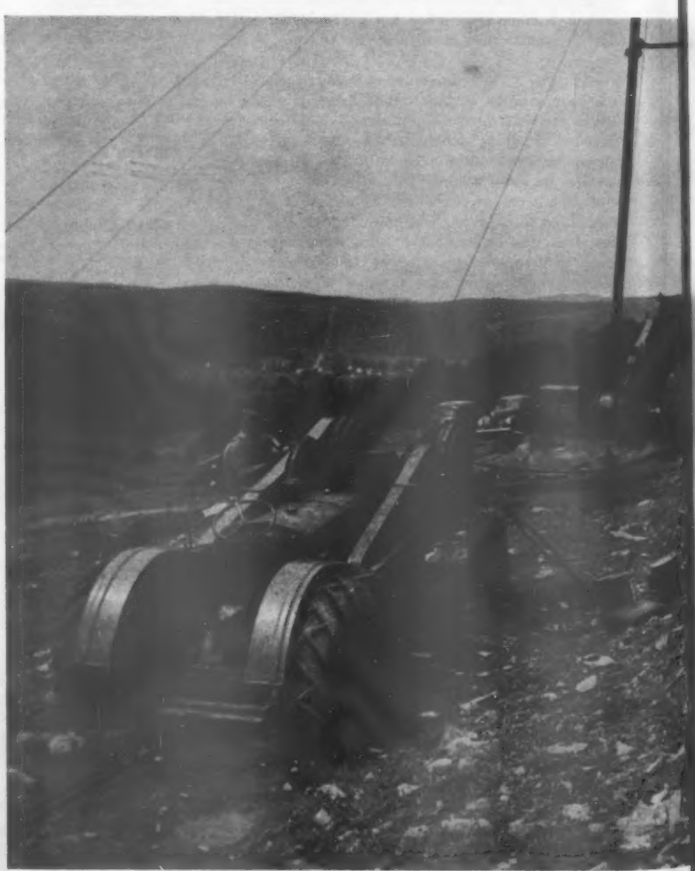

Allis-Chalmers Model M Double Drum Winch Tractor

Louden Devonian Test Flows Oil With Some Water

By
STAFF CORRESPONDENT

MATTOON, Ill., May 19.—The Louden pool of Fayette County, second largest pool in Illinois, had its first substantial production from the Devonian lime late last week when Jarvis Bros. et al 1-D Sinclair, NW NE 29-8n-3e, flowed and swabbed approximately 35 bbl. of oil an hour. Production was from 3,024 ft., with only 1 ft. of pay drilled. The hole started filling with oil as tools were being pulled and flow by heads started when sufficient gas had collected to force the oil from the hole.

However, the test has proved somewhat disappointing, for at the present time, it is making about one-fourth water. Whether this is coming from the Devonian or a more shallow formation has not yet been determined. No. 1-D Sinclair is located on one of the favorable highs, as far as the Chester series is concerned, and if the Devonian is showing water here, little may be expected in the way of Devonian throughout the rest of the field.

About 2 miles northeast of the new discovery, Whisenant & Trenchard have finally succeeded in getting 5½-in. casing set at 25-D Lilly, E½ NW SE 16-8n-3e, first Devonian test to get under way in the Louden field. The Devonian was topped at 3,060 ft. at 25-D Lilly, but due to a large underground cavity, circulation was lost twice and completion delayed. The test will be drilled in with cable tools in the near future. Hole is now bottomed at 3,100 ft.

Meanwhile, Jarvis Bros. have announced that the first Rosiclare sand saturation to be reported in Fayette County has been encountered at 1-D Yakey, their second Devonian venture in the Louden field. Nine feet of saturation was recovered in the Rosiclare between 1,701 and 1,712 ft., and its productiveness will be tested before the well is deepened to the Devonian.

The Louden field, discovered late in 1937, now has production from the Cypress, Paint Creek stray and Benoist. The McClosky has failed to pay off in this field. There is at the present time a total of nearly 1,800 producing wells in the field which covers an area of almost 30 sq. miles.

Since its discovery, development of the Louden field has been largely under control of the Carter Oil Co. and, wherever possible, the wells have been drilled on a 20-acre spacing system and pressure maintenance has been established in the field. Due to the orderly method of development of the field, a wasteful, unrestricted Devonian play such as was seen in the Salem field, probably will not occur in Louden.

Jackson County Pool Assured

First production encountered in Jackson County since the abandonment of the Ava-Campbell pool in 1934 was reported last week at Wiser Oil 1 Overholt, a wildcat in SE SW 22-7s-1w. The well was drilled to a total depth of 2,197 ft. in the Aux Vases, and after unsuccessfully testing that formation, was plugged back to the Benoist sand topped at 1,999 ft. Following the shooting of alloy casing opposite this sand, oil rose 500 ft. in the hole. The well is now being cleaned out following a second shot.

Observers estimated that 1 Overholt would make a 25-bbl. well in the Benoist sand.

RICHLAND COUNTY.—A wildcat in Bonpas Township, Richland County, Wiggins 1 Bowers, W½ SW SE 34-3n-14w, shot oil over the top of the derrick early last week during a drill-stem test of 4 ft. of McClosky saturation topped at 3,121 ft. Preparations were being made to cement casing at the end of the week.

Before saturation was encountered in the upper McClosky, operators planned to drill on to the lower McClosky. The well is about 7 miles from nearest production in the Dundas field of northern Richland County.

WHITE COUNTY.—Another new pool for White County seemed assured late last week when 11 ft. of saturation was recovered at Sachet 1 Ellis, a wildcat in NE SW SE 11-7s-8e, about 4 miles from nearest production in the recently discovered New Haven field. Pay was encountered in the Waltersburg from 2,154-65 ft., and preparations were being made at the end of the week to run a drill-stem test.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: Benton	6	1,988	12,809
Dundas	2	1,569	2,721
East Calvin	7	1,121	19,810
Enterprise, and West	2	1,128	6,136
Inman	3	402	6,240
Louden	4	875	6,229
Mount Carmel	4	365	8,146
N. New Harmony	4	481	11,296
W. Liberty	3	1,575	8,430
Other pools	10	1,326	22,225
Wildcats	2	148	5,937
Dry holes: Fields	1	.....	2,584
Wildcats	8	.....	14,858
Total	56	.....	127,421
Recompletions	8	1,500	.....

ILLINOIS COMPLETIONS

Clay County

Clay City: Pure 3 F. Holman-A, W½ SE NW 15-2n-8e, pumped 45 bbl., 5,000 gal. acid, McClosky 3,012-16 ft., 3,019-21 ft., 3,025-27 ft., 3,053-58 ft., T.D. 3,070 ft.

Clinton County

Wildcat: A. Niehoff 1 Fehrmann, N½ NW NW NE 23-1n-4w, dry, Vienna 705 ft., Tar Springs 712 ft., Glen Dean 768 ft., Hardinsburg 792 ft., Golconda 812 ft., Weller 932 ft., Benoist 1,086 ft., T.D. 1,090 ft.

Wilson 1 Lippert, NE NE NE 27-2n-1w, dry, T.D. 1,405 ft., not plugged.

Trio Oil 1 Paulsmeyer, NE NE NW 19-1n-1w, dry, base Pennsylvanian and Menard 870 ft., Glen Dean 1,069 ft., Weller 1,308 ft., Benoist 1,412 ft., cored 1,414-27 ft., received 13 ft. white water sand, T.D. 1,610 ft.

Effingham County

Mason: Hammer 2 Rose, NE NE NW 22-6n-5e, dry, Ste. Genevieve 2,458 ft., McClosky 2,498-2,502 ft., 2,504-11 ft., T.D. 2,584 ft., P.B. 2,520 ft.

Louden: Carter 1 Tipsword-Houran, NW SW NW 18-8n-4e, pumped 79 bbl., 10-qt. shot 1,508-11 ft., Cypress sand 1,507 ft., T.D. 1,511 ft.

Fayette County

Louden: Carter 6 C. Miller, SE SW NE 17-7n-3e, abandoned location.

Bialock & Walters 3 F. Harding, SE SE NW 18-7n-3e, pumped 40 bbl., 10-qt. shot 1,566-70 ft., T.D. 1,572 ft.

Carter 1 H. Zetche, NW NE SE 28-8n-3e, flowed 612 bbl., 40-qt. shot 1,489-1,502 ft., old well P.B. from 1,591-52 ft.

Carter 7 F. Durbin, NE SW NE NE 4-7n-3e, swabbed 156 bbl. oil and 48 bbl. water, 20-qt. shot 1,485-93 ft., Weller 1,480-1,502 ft., T.D. 1,559 ft.

Carter 2 R. Musser, NW SW SW 2-8n-3e, pumped 600 bbl., 60-qt. shot 1,492-1,516 ft., Weller 1,484 ft., T.D. 1,587 ft.

Franklin County

Benton: Shell 5 C. W. & F. Coal Co., SE NE SW 24-6s-2e, pumped 200 bbl., 15-qt. shot 2,114-24 ft., Tar Springs sand 2,090-2,124 ft., T.D. 2,124 ft.

Wegener 2 Gentry, SW NW SW 24-6s-2e, pumped 400 bbl., 30-qt. shot 2,063-87 ft., Tar Springs sand 2,065 ft., T.D. 2,091 ft.

Adkins 3 Rice, NE SE NW 25-6s-2e, pumped 420 bbl., 30-qt. shot 2,119-37 ft., Tar Springs sand 2,108 ft., T.D. 2,137 ft.

Adkins 4 Rice, SE SE NW 25-6s-2e, pumped 400 bbl., 40-qt. shot 2,119-43 ft., Tar Springs sand 2,105 ft., T.D. 2,143 ft.

Shell 7 W. Doty et al, SW SW NE 25-6s-2e, pumped 328 bbl., 15-qt. shot 2,136-46 ft., Tar Springs sand 2,109-17 ft., 2,019-54 ft., T.D. 2,154 ft.

Shell 1 McKemie-B, NW SE NE 25-6s-2e, pumped 240 bbl., 15-qt. shot 2,144-54 ft., Tar Springs sand 2,121-30 ft., 2,132-60 ft., T.D. 2,160 ft.

Stewart Oil 1 Simpson, N½ SE NW NE 26-6s-2e, location abandoned.

Menhall 2 Moore, E½ W½ W½ 25-6s-2e, location abandoned.

Gallatin County

Inman: Phillips 1 Egyptian T. & T., S½ SW SE NE 16-8s-10e, pumped 82 bbl. oil and 33 bbl. water, 20-qt. shot 2,072-80 ft., T.D. 2,083 ft., P.B. 2,080 ft.

Halbert et al 2 Curry, NW SW NW 15-8s-10e, pumped 200 bbl., 15-qt. shot 2,073-81 ft., Tar Springs 2,067-72 ft., T.D. 2,081 ft.

Buell & Herndon 2 Egyptian T. & T., N½ NE NW SE 16-8s-10e, pumped 120 bbl., 10-qt. shot on bottom, Tar Springs 2,071 ft., T.D. 2,076 ft.

Hamilton County

Dahlgren: Sinclair 2 M. F. Hall, SW SW SE 27-3s-5e, pumped 621 bbl., 5,000 gal. acid, McClosky 3,283-94 ft., T.D. 3,299 ft.

Hoodville: Ohio 10 O. Matheny, NW NW NE 10-6s-6e, pumped 92 bbl., 10-qt. shot 3,059-69 ft., Aux Vases 3,056 ft., T.D. 3,069 ft.

Wildcat: Adkins 2 Federal Chem. & Coke Co., NE NE SE 17-7s-6e, dry, T.D. 3,344 ft.

Jasper County

West Liberty: Pure 1 C. King-A, E½ NW SE 5-5n-10e, pumped 232 bbl., 5,000 gal. acid, McClosky 2,767-72 ft., 2,790-93 ft., T.D. 2,810 ft.

Pure 2 C. King-A, W½ SE SE 5-5n-10e, flowed 1,182 bbl. through 1-in. choke, 5,000 gal. acid, McClosky 2,753-62 ft., 2,782-85 ft., T.D. 2,805 ft.

Pure 2 Canny, W½ SE SE 17-5n-10e, pumped and flowed 161 bbl. through ½-in. choke, 5,000 gal. acid, McClosky pay 2,775-82 ft., T.D. 2,815 ft.

Lawrence County

Dennison: Big 3 Oil 2 Gillespie, SW SW SE SW 1-2n-12w, pumped 51 bbl. oil and 150 bbl. water, saturated sand 289-323 ft., T.D. 323 ft.

Marion County

East Patoka: Schoenfeld et al 3 Hudspeth, NE NE SE SE 27-4n-1e, pumped 56 bbl., 6-qt. shot 1,357-63 ft., Weller 1,357-63 ft., T.D. 1,364 ft.

Shell 2 Headley, NE NW NE 34-4n-1e, pumped 139 bbl. oil and 10 bbl. water, 5-qt. shot 1,363-66 ft., Weller 1,356-59 ft., 1,361-66 ft., T.D. 1,366 ft.

Randolph County

Wildcat: Oswald et al 1 Wiley, SW SW SE 14-5s-6w, Location abandoned.

Lachtrop 3 Schulze, SW SE NW 2-7s-6w, dry, Aux Vases 705 ft., T.D. 950 ft.

Richland County

Dundas: Pure 1 J. W. McCormack, E½ NE NE 30-5n-10e, flowed 1,207 bbl., 5,000 gal. acid, McClosky 2,812-21 ft., T.D. 2,855 ft.

Pure 1 Nicholas, W½ NE NW 29-5n-10e, flowed 362 bbl., 5,000 gal. acid, McClosky 2,825-30 ft., T.D. 2,866 ft.

St. Clair County

Wildcat: G. A. Morris 1 V. Rasp, E½ NW NW SW 32-2n-7w, dry, Salem 837 ft., T.D. 960 ft., junked hole.

Wabash County

Keensburg: Continental 3 S. M. Dague, SW NE NW 20-2s-13w, pumped 140 bbl., reamed alloy casing 1,705-39 ft., Cypress sand 2,462-88 ft., T.D. 2,488 ft.

Allendale: Joe Young 10 Stillwell, NE NW SE 1-1n-12w, pumped 12 bbl., 60-qt. shot 2,000-18 ft., re-shot 30-qt. on bottom, Benoist 2,000 ft., T.D. 2,018 ft.

Geary Oil 1 McClain, SW SE NE 36-2n-12w, pumped 45 bbl. oil and 10 bbl. water, Benoist 1,951 ft., T.D. 1,963 ft.

Mount Carmel: H. Meyers 2 E. L. Denham, SE SW SE 17-1s-12w, pumped 40 bbl., 55-qt. shot 1,554-64 ft., Palestine 1,540 ft., T.D. 1,564 ft., P.B. 1,551 ft., drilled out to 1,564 ft.

Shell 1 E. Abell, SW NW SW 17-1s-12w, pumped 158 bbl., 10-qt. shot 2,038-48 ft., Cypress sand 2,030 ft., T.D. 2,049 ft.

Shell 3 Mount Carmel Comm., NE SW NE 18-1s-12w, pumped 54 bbl., 5-qt. shot 2,090-94 ft., Cypress sand 2,083 ft., T.D. 2,094 ft.

Shell 1 Steckler, NE NE NW SE 18-1s-12w, pumped 113 bbl., 10-qt. shot 2,083-90 ft., Cypress sand 2,072 ft., T.D. 2,439 ft., P.B. 2,093 ft.

Wildcat: Indillky Oil 1 Price estate, NE SE SE 23-1n-12w, dry, Renault 2,180 ft., Aux Vases 2,190-2,205 ft., Ste. Genevieve 2,226 ft., Rosiclare 2,255 ft., Fredonia 2,260 ft., McClosky 2,273-82 ft., T.D. 2,292 ft.

Wayne County

Enterprise: J. W. Sanders 3 Hubble, E½ NW SE 30-2n-8e, flowed 900 bbl., 5,000 gal. acid, McClosky 3,029-36 ft., 3,044-48 ft., T.D. 3,073 ft.

West Enterprise: Pure 1 M. Harrington-A, E½ SW SW 1-1n-7e, pumped 228 bbl. oil and 5 bbl. water, 5,000 gal. acid, McClosky 3,022-25 ft., 3,035-37 ft., T.D. 3,063 ft.

Wildcat: Indilky Oil 1 Price estate, NE SE SE 23-1n-7e, pumped 7 bbl. oil and 7 bbl. water in 12 hr., pumped off, 5,000 gal. acid, Fredonia 2,996 ft., T.D. 3,065 ft.

White County

Mill Shoals: New Penn. 3 H. G. and C. A. French, SE SE NE NE 19-3s-8e, pumped 125 bbl. oil and 50 bbl. water, 50-qt. shot 3,240-65 ft., Aux Vases 3,235-60 ft., T.D. 3,265 ft.

East Calvin: Magnolia Pet. 2 J. J. Bond, NE NW SE 8-4s-14w, pumped 163 bbl., 50-qt. shot 2,798-2,827 ft., Aux Vases 2,806 ft., old well deepened from 2,719-2,828 ft.

Magnolia 6 J. J. Bond, NW NW SE 8-4s-14w, pumped 100 bbl. oil and 2 bbl. water, 40-qt. shot 2,805-25 ft., Aux Vases 2,805-25 ft., old well deepened from 2,725-2,827 ft.

Magnolia Pet. 1 J. J. Bond, SE NW SE 8-4s-14w, pumped 82 bbl. oil and 16 bbl. water, 80-qt. shot 2,800-30 ft., Aux Vases 2,797-2,831 ft., old well deepened from 2,714-2,835 ft.

Pure 3 Potter, SW SW NW 9-4s-14w, pumped 124 bbl., 35-qt. shot 2,802-30 ft., old well deepened from 2,700-2,830 ft.

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For protective efficiency nothing equals the WEDGE Thread Protector—it is the only one that gives 4-POINT PROTECTION. This is because of EXCLUSIVE patented features. Look at the illustration and see how the first few threads are cleared and how it locks inside of pipe. The best way to prevent damage to threads in transit is to specify WEDGE Thread Protectors on each pipe order.

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2. LOCKS INSIDE OF PIPE
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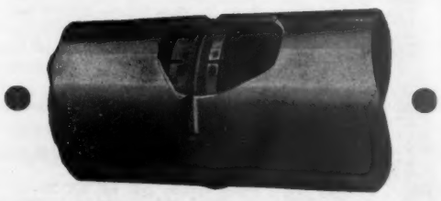

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use WEDGE Thread Protectors-Chill Rings

French & Lavender 3 Hon, NE NW SW 33-3s-14w, pumped 105 bbl., 60-qt. shot 2,783-2,824 ft., Aux Vases 2,777 ft., T.D. 2,825 ft.
Tipton et al 8 Boltinghouse, NE SE NE 17-4s-14w, location abandoned.
Carroll 1 Boltinghouse, N½ SE NE NE 17-4s-14w, flowed 248 bbl., 60-qt. shot 2,840-63 ft., Aux Vases sand 2,831 ft., T.D. 2,863 ft.
P. Miller 2-A-2 Ford heirs, SW SW SW 16-4s-14w, pumped 85 bbl., 120-qt. shot 2,578-2,603 ft., Cypress sand 2,574 ft., T.D. 2,603 ft.
Bell Bros. 7 Skiles, NW NE SW 16-4s-14w, flowed 257 bbl., 3,000 gal. acid, McClosky 2,920-35 ft., T.D. 2,935 ft.
Bell Bros. 6 Skiles, SE NW NW 16-4s-14w, pumped 60 bbl., 140-qt. shot 2,824-63 ft., Aux Vases 2,824-63 ft., T.D. 2,865 ft.
Burr Lambert 8 Calvin, NE NE SW 9-4s-14w, pumped 16 bbl. in 12 hr., 60-qt. shot 2,830-58 ft., Aux Vases sand 2,829-35 ft., T.D. 2,858 ft.
Buell & Herndon 4 Garrison heirs, NE NE NW 8-4s-14w, flowed 350 bbl., 80-qt. shot 2,835-60 ft., Aux Vases sand 2,835-60 ft., T.D. 2,861 ft.
North New Harmony: Superior 5 H. C. Ford-D, SE NW NW 34-4s-14w, pumped 100 bbl., 80-qt. shot 2,127-41 ft., old well deepened from 2,141-2,835 ft.
Superior 1 Greathouse, SE SW SW 34-4s-14w, pumped 119 bbl., 20-qt. shot 2,586-2,604 ft., perf. 2,701-33 ft., old well worked over, T.D. 2,924 ft.
Superior 6 H. C. Ford et al-D, NW NW NW 34-4s-14w, pumped 200 bbl., perf. 2,557-2,606 ft., old well worked over, T.D. 2,735 ft.
Sun 3 Henning, SW SW NW 33-4s-14w, pumped 73 bbl., 70-qt. shot 2,702-31 ft., Benoist 2,697-2,732 ft., T.D. 2,732 ft.
Sun 26 E. R. Greathouse, SE NE SW 33-4s-14w, pumped 150 bbl., 60-qt. shot 2,707-33 ft., Benoist 2,700-34 ft., T.D. 2,734 ft.
Superior 9 H. M. Ford, NE NW SE 28-4s-14w, pumped 210 bbl., 150-qt. shot 2,690-2,730 ft., 400-qt. shot 2,689-2,721 ft., Benoist 2,678-2,733 ft., T.D. 2,920 ft., P.B. 2,856 ft.
Bradley et al 1 C. G. French, SE NE NE 7-5s-14w, pumped 48 bbl. oil and 6 bbl. water, 70-qt. shot 2,896-2,910 ft., 300-qt. shot 2,896-2,910 ft., Aux Vases 2,848 ft., T.D. 2,910 ft.
Wildcat: Cherry & Kidd 1 Karch, SW NW NE 24-6s-10e, pumped 141 bbl., 70-qt. shot 2,845-65 ft., Aux Vases sand 2,841 ft., T.D. 2,872 ft.
Ryan et al 1 Pomeroy, NE NE SE 4-6s-10e, dry, St. Louis 3,205 ft., T.D. 3,207 ft.

ILLINOIS DRILLING REPORT

Adams County

C. Schachtsick 1 J. Richart....NE SW NW 12-2s-8w Drilling 894 ft.
R. Hussong 1 fee.....SW NE SW NW 21-1s-6w Drilling 400 ft.

Bond County

Regent Oil 1 Wafer.....N½ SE NW 36-7n-4w Set 8-in. 438 ft., S.D. 750 ft.

Champaign County

Union Prod. Pet. 1 Messman.....NW NE 18-17n-11e Silurian 720 ft., Joliet 1,250 ft., Kankakee 1,340 ft., Maquoketa 1,460 ft., drilling 1,570 ft.
Union Prod. Pet. 1 C. Kirby NW SE SW SW 20-20n-10e First report, pits.

Christian County

W. Marlow 1 Howell.....SE SE NE 26-15n-2w Set 12-in. 90 ft., 10-in. 385 ft., S.D. 385 ft.

Clinton County

A. W. Gerson 1 Hy Bilkhart....SW NW NW 22-1n-5w Golconda 615 ft., Cypress 780 ft., Weller 790 ft., Paint Creek 887 ft., Benoist 954 ft., water, Renault 998 ft., Aux Vases 1,003 ft., Ste. Genevieve 1,039 ft., St. Louis 1,085 ft., Salem 1,220 ft., Osage 1,475 ft., drilling 1,585 ft.
Jahns Oil 1 D. Sanders..... SW NW NE 17-3n-1w First report, moving in rotary tools.
Algona 1 Marshall.....SE SE SW 12-1n-1w T.D. 3,137 ft., fishing core barrel.
Max Conrey 1 B. O. Maschaoff SE SW SW 18-1n-2w S.D. 1,325 ft.
Hughes 2 Holman.....NE SW SE 10-2n-1w S.D. 1,340 ft.

Crawford County

Roy Powers 1 Kirtland.....NE NW 7-6n-13w Slight show oil 1,684 ft., base Pennsylvanian 1,412 ft., Cypress 1,490 ft., Paint Creek 1,593 ft., Ste. Genevieve 1,698 ft., Rosiclare 1,727 ft., Fredonia 1,765 ft., Chattanooga 2,945 ft., Devonian 3,095 ft., Salem 2,155 ft., S.D. 3,116 ft.
J. Steele 1 M. S. Davis.....NE SW NE 23-7n-13w Salem 1,800 ft., T.D. 1,892 ft.

Cumberland County

Joe Hassett 1 Travis.....NW NW SW 21-9n-10e First report, spud.

Du Page County

I. C. R. Synd. 1 Bartlett Village SE NW NW 2-40n-9e Drilling 645 ft.

Edgar County

McDevitt et al 1 Hammond W½ NW NW SE 24-12n-14w Location, first report.
Ray Brown 1 Redman.....NW NW SW 13-12n-14w First report, spud.
E. Link 1 Kirkham.....SW NW SE 14-12n-14w Set 4-in. 302½ ft., pumped 4 bbl. oil and 1 bbl. water an hour, T.D. 305 ft., testing.

Edwards County

R. B. Martin 1 Lester.....W½ SW SW 19-2s-10e T.D. 3,351 ft., pumped 127 bbl., 6 per cent water, testing.

Effingham County

Lynch & Jansen 1 Burk.....W½ SE NW 27-6n-5e Glen Dean 2,004 ft., drilling 2,070 ft.

Fayette County

T. A. Booth et al 1 Kern.....SE NE NE 29-5n-1w First report, elev. 505 ft., Glen Dean 1,077 ft., Benoist 1,374 ft., Renault 1,384 ft., Aux Vases 1,418 ft., drilling 1,431 ft.

Ford County

Nelson et al 1 Erp.....SW NW SE 19-24n-7e Drilling 3,000 ft.

Franklin County

E. S. Adkins 1 Old Ben-F.....NE NW SE 36-7s-2e No. 5 coal 467 ft., base Pennsylvanian 1,610 ft., Kincaid 1,708 ft., Degonia 1,751 ft., Clore 1,796 ft., Palestine 1,816 ft., Waltersburg 2,034 ft., Vienna 2,098 ft., Tar Springs 2,111 ft., Glen Dean 2,172 ft., Hardinsburg 2,230 ft., Golconda 2,310 ft., Cypress 2,470 ft., Paint Creek 2,560 ft., Benoist 2,712 ft., Aux Vases 2,735 ft., drilling 2,865 ft.
Yingling et al 1 Cyrus Webb..E½ E½ SW SE 16-5s-4e Menard 2,295 ft., Waltersburg 2,388 ft., Vienna 2,412 ft., Tar Springs sand 2,436-2,502 ft., Glen Dean 2,506 ft., Hardinsburg 2,558 ft., Hardinsburg sand 2,580-2,657 ft., Golconda 2,657 ft., drilling 2,817 ft.
Shiek & Buerkle 1 Akin.....SE SE SE 16-6s-4e Degonia 2,014 ft., Clore 2,102 ft., Menard 2,276 ft., Waltersburg 2,330 ft., Glen Dean 2,514 ft., Hardinsburg 2,565 ft., Hardinsburg sand 2,596 ft., Golconda 2,793 ft., Cypress 2,798 ft., Cypress sand 2,820 ft., drilling 2,945 ft.

Gallatin County

Blackstock 1 Cox.....NE NW SW 2-8s-9e First report, moving in rotary tools.
Vanderbark 1 Browning.....NW NW SE 10-8s-10e Location, first report.
Hamberg et al 1 Hughes.....SE NW SW 9-8s-10e Rigging up rotary.
Ryan et al 1 Crunk.....N½ NE NW SE 9-8s-9e Glen Dean 2,332 ft., Hardinsburg 2,408-42 ft., Golconda 2,435 ft., Barlow 2,579 ft., Cypress sand 2,614 ft., 7-in. 2,610 ft., waiting on cement.

Hamilton County

Ryan Oil 1 Hund.....SE SE NE 28-6s-7e Location, first report.

Jasper County

C. L. Erbin 1 H. Garner.....SW NW SE 16-6n-8e Drilling 50 ft.

Jefferson County

L. & W. Drlg. 1 C. O. Sargent ..NE SW NW 22-1s-2e T.D. 1,938 ft., filled up 1,500 ft. fluid after shot, to squeeze.

Lawrence County

C. Everetts 1 Catt.....SW SE SW 23-2n-12w Beal 1,369 ft., cored 1,378-92 ft., received 13 ft. saturated sand and 1 ft. dry sand, S.D. for casing 1,392 ft.
W. Payne 1 H. Payne .....NW SW NW 20-3n-11w Set 8-in. 1,493 ft., drilling 1,502 ft.

Marion County

Hollingsworth 1 Mason.....NW NE NE 19-3n-1e Location, first report.
Austin Oil 1 Smith.....SE SE SW 12-3n-2e Rig, first report.
Hudson & Hess 1 Ben Young.....SW SW SW 7-2n-2e Paint Creek 1,825 ft., Benoist 1,961 ft., Aux Vases 1,984 ft., Ste. Genevieve 2,058 ft., Rosiclare 2,074 ft., Fredonia 2,095 ft., McClosky 2,103-05 ft., 2,170-76 ft., St. Louis 2,236 ft., Salem 2,337 ft., T.D. 2,381 ft.
Perry et al 1 Ebart.....SW SE SE 12-4n-1e Drilling 1,320 ft.
Dunbar 1 Teschner.....SW SW 27-3n-1e Fishing 700 ft.

Montgomery County

H. C. Detrick 1 W. H. Barnes NW NE SE 20-10n-2w Slight show gas 2,270 ft., S.D. 2,290 ft.

Randolph County

J. R. Rankin 1 B. Bierman.....SW SW SE 3-7s-5w Fishing 1,110 ft.
Ruwaldt 1 Schuette..... NE NE SW 35-5s-5w T.D. 1,010 ft., 5½-in. 984 ft., P.B. 978 ft., to perf.
Gode & Murphy 1 McIntyre.....SW SW SW 10-5s-5w Drilling 730 ft.
General O. & G. 1 J. Schmall... SE NE SW 27-4s-7w Rigged up standard tools and S.D.

Richland County

P. Osborne 1 Bowers..... SW SW SE 34-3n-13w Glen Dean 2,576 ft., Hardinsburg 2,590 ft., Golconda 2,666 ft., Barlow 2,740-51 ft., Weller 2,763-73 ft., Renault 2,964 ft., Aux Vases 3,034 ft., Ste. Genevieve 3,070 ft., show oil 3,121-26 ft., cored 3,123-29 ft., received 30 in. saturated oolites and 12 in. hard oolites, T.D. 3,129 ft.
C. B. Hill et al 1 Wood..... NE SE SE 21-2n-14w Benoist 2,858 ft., Aux Vases 2,907-88 ft., Ste. Genevieve 3,008 ft., McClosky 3,016-21 ft., S.D. 3,021 ft.
J. Davis 1 S. C. Shan.....SW SW NW 27-3n-9e First report, rig.

St. Clair County

G. Morris 1-A Rasp.....NW NW SW 32-2n-7w First report, drilling 650 ft.

Saline County

Thompson 1 O. Carter.....NW NE SE 16-8s-7e Drilling plug.
Carter & Vaughn 1 Roberts ..... SE SW NE 6-8s-7e Set 10-in. 96 ft., waiting on cement.

Shelby County

Rose & Durbin 1 Flenner.....SW SW SE 9-10n-4e Set 7-in. 1,733 ft., drilling 1,915 ft.
Sloan 1 Powers..... SE SE SE 1-10n-2e First report, 10-in. 189 ft., drilling 555 ft.

Tazewell County

Bartelmay 1 Mathis.....SW NW SW 24-25n-3w Drilling 1,282 ft.

Wabash County

Burr Lambert 1 Baumgart.....NE NE SE 6-1s-12w First report, drilling 1,360 ft.

Wayne County

Gordon-Muhlbach 1 P. Muhlbach W½ SE SW 36-2n-8e S.D. 3,120 ft.

White County

Cherry & Kidd 1 M. Prell..... NE SE SW 24-6s-10e First report, rigging up rotary.
Ryan Oil 1 Barnes..... SE SW SE 12-6s-10e First report, rigging up rotary.
Sallee Bros. 1 Emil Doerr.....NE NE SE 21-4s-9e Menard 2,393 ft., Hardinsburg 2,672 ft., Hardinsburg sand 2,708-46 ft., Golconda 2,757 ft., Barlow 2,882 ft., Cypress sand 2,897 ft., Paint Creek 2,958 ft., Benoist 3,068-3,111 ft., Aux Vases 3,129 ft., 3,158 ft., 3,176 ft., Ste. Genevieve 3,212 ft., drilling 3,249 ft.
L. B. Jackson 1 Hanna.....NE NE NE 28-5s-10e T.D. 3,155 ft., 5½-in. 3,155 ft., waiting on cement.
Continental 1 Ackerman.....NE NW NE 25-5s-10e

(Continued on Page 191)

St. Peter Shows Oil in Wayne County, Ohio, Test

By STAFF CORRESPONDENT

WOOSTER, Ohio, May 19.—The sub-Trenton test of the Ohio Oil Co., Wooster Township, Wayne County, had a small showing of oil in a white sandy formation under the Trenton, in what may be the St. Peter horizon. A green formation was logged at 5,710-27 ft., a white sandy formation 5,727-44 ft., broken white 5,744-51 ft., white was picked up again at 5,751-87 ft., broken 5,787-92 ft., and white from 5,792 ft. to present depth; oil showed at 5,763 ft. and 5,799-5,802 ft., 50 gal. in 24 hours.

On the Cambridge arch, two tests have reached the Corniferous lime. On the lower western flank in Washington County, 5 miles west of Marietta, C. W. Ross et al 1 Charles Ammon, Section 29, Warren Township, logged the lime at 4,155 ft., and are shut down with a crooked hole at 4,190 ft. In Guernsey County, 6 miles west of Cambridge, Adams Township, Section 16, Ohio Oil Co. 1 R. Marshall is drilling ahead in the lime after finding the Oriskany dry at 3,373-83 ft., top of lime 3,253 ft.

NORTHWEST OHIO.—In northwestern Ohio the Pure Oil Co. 1 Judge Kear, Section 13, Richland Township, Wyandot County, is drilling in the basal portion of the Trenton at 500 ft. in top of Trenton logged at 1,305 ft.

Muskingum County continues to yield good gassers in the Clinton at the 4,000-ft. level. Other completions were small in volume with exception of Knox County. Sub-Trenton test in Licking County has been officially abandoned after standing several months.

SOUTHEAST OHIO.—In Columbiana County, Southeast Ohio, the Natural Gas Co. of West Virginia topped the Onondaga at 4,167 ft. in the test on the W. Watson farm, Section 25, Wayne Township, and is drilling 170 ft. in that formation at 4,337 ft.

SUMMARY OF COMPLETIONS

Oil wells	2	12	1,672
Gas wells	9	*6.1	21,594
Dry holes	22	.....	44,198
Total	33	.....	67,464
Recompletions	1	20	.....

Indiana

	No.	Bbl.	Footage
Oil wells	3	658	7,958
Dry holes	5	.....	12,701
Total	8	.....	20,659

Eastern Kentucky

Oil wells	1	100	1,050
Dry holes	6	*1.7	13,968
Total	7	.....	15,018

Western Kentucky

Oil wells	1	10	527
Dry holes	1	.....	1,563
Total	2	.....	2,090

*Million cu. ft.

OHIO COMPLETIONS

Ashland County

Jackson Township: Butler Bros. 1 H. E. Morr, Sec. 21, dry, no Clinton sand, T.D. 2,949 ft.
Mohician Township: W. G. Obrecht 2 L. C. Galloway, Sec. 32, dry, Berea, T.D. 700 ft.
Montgomery Township: McMalley 1 E. M. Bone, Sec. 26, dry, Berea, T.D. 547 ft.
Orange Township: Ohio Fuel 3 Mary Gantz, Sec. 24, 28,000 cu. ft. gas, Clinton, plugged, T.D. 2,895 ft.

Athens County

Bern Township: Bern O. & G. 2 D. W. Lambert heirs, Sec. 18, dry, Maxon (water), T.D. 985 ft.
Carthage Township: Ohio Fuel 2 V. L. Person, Sec. 25, 205,000 cu. ft. gas, Berea, T.D. 1,712 ft.
Rome Township: Mathews Oil Co. 1 Ken Hayes, Sec 25, 10,000 cu. ft. gas, second Berea, plugged, T.D. 1,477 ft.
York Township: Ohio Fuel 194 Sunday Creek Coal, Sec. 32, dry, injun, T.D. 485 ft.

Fairfield County

Rush Creek Township: City Natural 1 J. Raab, Sec. 6, dry, Clinton, T.D. 2,389 ft.

Gallia County

Addison Township: D. T. Orndoff 1 E. S. Jones, Sec. 25, 60,000 cu. ft. gas, shot, second Berea, T.D. 1,684 ft.

Guernsey County

Cambridge Township: Ronshausen 1 Samuel Taylor heirs, Sec. 5, 50,000 cu. ft. gas, shot, Berea, T.D. 1,232 ft.
Liberty Township: Ohio Fuel 1 H. L. Mathers, Sec. 16, dry, Gordon, T.D. 1,827 ft.
Westland Township: Wilbur Keith 1 T. B. Ringer, Sec. 1, 25,000 cu. ft. gas, shot, Berea, T.D. 1,200 ft.

Hocking County

Ward Township: Preston Oil 192 Sunday Creek Coal Co., Sec. 12, dry, Clinton, T.D. 3,456 ft.

Holmes County

Monroe Township: Ohio Fuel 1 Al. Mohr, Lot 25, fourth quarter, dry, Clinton, T.D. 3,481 ft.
Washington Township: Ohio Fuel 1 M. S. Lifer, Sec. 28, dry, Clinton, T.D. 2,898 ft.

Knox County

Union Township: Ewing et al 1 C. V. Banbury, Sec. 6, 1,250,000 cu. ft. gas, Clinton, T.D. 2,751 ft.
Ohio Fuel Gas Co. 4 Lewis Meakley, SE Sec. 5, 58,500 cu. ft. gas, Clinton sand, T.D. 2,752 ft.
Ohio Fuel Gas Co. 1 W. McElroy, SE Sec. 18, dry, Clinton sand, T.D. 3,010 ft.
B. Johnson 1 Burch Ferenbaugh, Lot 35, dry, Clinton sand, T.D. 3,008 ft.

Lawrence County

Windsor Township: Dave Fox 1 Edgar Pratt, Sec. 30, 120,000 cu. ft. gas, shot, Ohio shales, T.D. 2,583 ft.

Licking County

Eden Township: McCloy, Inc., 1 Ed Bebout, Sec. 17, dry, Clinton, T.D. 2,810 ft.
Jersey Township: McCloy, Inc., 1 N. A. Rowe, Sec. 21, dry, Trenton 3,320-3,965 ft., dolomite with trace of sand 3,965-85 ft., H.F.W. 4,349 ft., T.D. 4,360 ft.
Newton Township: A. Willey 3 Addie Pound, fourth quarter, 500,000 cu. ft. gas, shot, Newburg, T.D. 2,239 ft.
C. A. Davis 2 Lawrence Bolen, Lot 1, fourth quarter, 240,000 cu. ft. gas, Clinton, T.D. 2,620 ft.
Madison Township: Ohio Fuel Gas Co. 1 Arthur Nefberger, Sec. 1, 2,000,000 cu. ft. gas, Clinton sand, T.D. 2,765 ft.
Perry Township: McCloy Bros. 2 Emmet Hoover, Sec. 3, drilled deeper from Berea, 20 bbl., 200,000 cu. ft. gas, shot, Clinton, T.D. 2,938 ft.

Lorain County

Pittsfield Township: Ohio Fuel 1 William White, Lot 141, 170,000 cu. ft. gas, Clinton, T.D. 2,370 ft.

Medina County

Chatham Township: Thornton Producing Corp. 27-F Sanford & Watson, Tr. 10, Lot 3, 5 bbl., Berea, T.D. 335 ft.
Thornton Producing Corp. 28-F Sanford & Watson, 5 bbl., Berea, T.D. 372 ft.
Thornton Producing Co. 29-F Sanford & Watson, dry, Berea, T.D. 392 ft.
Thornton Producing Co. 30-F Sanford & Watson, 5 bbl., Berea, T.D. 389 ft.
Thornton Producing Co. 32-O Sanford & Watson, input, Berea, T.D. 352 ft.
Thornton Producing Co. 33-O Sanford & Watson, input, Berea, T.D. 360 ft.
Preston Oil 1 Charles Melton, Lot 19, Tr. 3, 5 bbl., shot, Berea, T.D. 410 ft.

Meigs County

Orange Township: Ohio Fuel Gas Co. 1 Guy and Nina Dean, Sec. 30, 15 bbl., first Berea, T.D. 1,699 ft.
Rutland Township: H. M. Nelson 1 James Kincade, Sec. 23, dry, Keener (water), T.D. 848 ft.

Morgan County

Marion Township: Harris 1 Fred White, Lot 1, 820,000 cu. ft. gas, Brill, T.D. 936 ft.
Williams Bros. 1 L. Choguill, Sec. 5, 260,000 cu. ft. gas, Brill, T.D. 950 ft.
W. S. Harris 1 E. S. Kinsey, Lot 2, 40,000 cu. ft. gas, Salt sand (Maxon dry), T.D. 1,064 ft.

Monroe County

Summit Township: A. E. Robinson 2 Etta Baker, Sec. 5, dry, Squaw, T.D. 1,575 ft.

Muskingum County

Brush Creek Township: Ohio Fuel 1 H. C. Floyd, Sec. 15, 2,600,000 cu. ft. gas, Clinton, T.D. 4,048 ft.
Pure Oil 1 Ida McHenry, Sec. 16, 3,200,000 cu. ft. gas, Clinton, T.D. 4,098 ft.
Wayne Township: Atha 2 Charles Frick, Sec. 14, dry, Clinton and Medina, T.D. 3,950 ft.

Noble County

Marion Township: Ohio Fuel 1 J. E. Guller, Sec. 11, show of gas, Berea, shot, plugged, T.D. 1,736 ft.
Seneca Township: Harry Clymer 1 C. W. McAuly, Sec. 33, dry, Berea, T.D. 1,720 ft.

Perry County

Reading Township: Ohio Fuel 1 Anna Snider, Sec. 4, 300,000 cu. ft. gas, shot, Clinton, T.D. 3,107 ft.

Stark County

Lake Township: Belden et al 1 H. H. Heldenbrand, Sec. 27, 700,000 cu. ft. gas, shot, Clinton, T.D. 4,579 ft.

Seneca County

Big Spring Township: Lantz & Jones 1 Lena Brandt, Sec. 21, 50,000 cu. ft. gas, shot, Trenton, plugged, T.D. 1,580 ft.

Tuscarawas County

Lawrence Township: Natural Gas Co. of W. Va. 2 Emery Dayton, first quarter, 660,000 cu. ft. gas shot, Clinton, T.D. 4,737 ft.

Washington County

Barlow Township: Ohio Fuel 5 H. J. Tresch, Sec. 10, 85,000 cu. ft. gas, Squaw, T.D. 1,504 ft.
Charles D. Fogle 4 fee, Sec. 12, dry, Injun, T.D. 1,530 ft.
Anderson et al 5 A. W. Benson, Sec. 4, 10 bbl., natural, second Cow Run, T.D. 916 ft.
Grandview Township: C. W. McCall 5 James Ewers, Sec. 21, 3 bbl., shot, Keener, T.D. 1,550 ft.
Independence Township: Herlan et al 1 Edward Matheny, Sec. 32, 2 bbl., shot, Salt sand, T.D. 1,017 ft.
Liberty Township: Otto Heldman 2 W. L. Rapp, Sec. 21, 50,000 cu. ft. gas, Germantown sand (Keener dry), T.D. 1,398 ft.

INDIANA

EVANSVILLE, Ind., May 19.—Dirickson 1 Utley, semiwildcat in Black Township, Posey County, was standing with about 1,000 ft. of oil and 700 ft. of water in the hole early last week. No. 1 Utley, located in NW SW NE 26-6s-13w, is ½ mile southwest of Gulf 1 Schrieber, Cypress discovery well.

Plug was drilled into the Cypress to 2,452 ft. and hole filled with 2,300 ft. of fluid in 9 hours. On a 7-hour swab test, the well made 120 bbl. of oil.

Meanwhile, surface casing has been set for a new wildcat start on the McFadden farm in SW NW SW 16-6s-14w. The test is being drilled by Whisenant & Trenchard on a Gulf Refining Co. farmout. It is about ½ mile southeast of a dry hole drilled last year by Whisenant & Trenchard on the Jon Larkin farm.

GIBSON COUNTY.—Along the west edge of the Griffin pool in western Gibson County, W. C. McBride et al 2 Jesse Blood, NE SE NE 28-3s-14w, is being put on pump as a McClosky producer. The well swabbed about 150 bbl. of oil in a 24-hour test after an acid treatment of 2,000 gal. in the McClosky pay.

Meanwhile, in Montgomery Township of Gibson County, a new test has been started in SW SE SW 8-2s-12w. Ward Wickwire et al 1 Davis was spudded at the end of the week and drilling was expected to be well underway by the end of this week.

VANDERBURG COUNTY.—Preparations were being made last week to test about 14 ft. of Waltersburg sand saturation at Travis et al 1 Keck, SE SW NE 6-5s-11w, in western Vanderburg County. An electrical survey is reported to have shown 9 ft. of excellent saturation and 5 ft. of saturation described as fair. Bottom of the hole still is in the pay.

INDIANA COMPLETIONS

Gibson County

Griffin: Joe Bander et al 42 Cooper, SW NW SE 13-3s-14w, pumped 85 bbl., 40-qt. shot 2,487-2,503 ft., T.D. 2,503 ft.
Hall Edwards 35 Maier, NW NE NW 14-3s-14w, flowed 375 bbl., natural, pay 2,523-54 ft., T.D. 2,554 ft.
Continental 5 Mumford, NW SE NW 25-3s-14w, dry, tested water, T.D. 2,915 ft.
South Griffin: Continental 37 Bozeman, NW SW NW 26-3s-14w, pumped 198 bbl., perf. 2,858-64 ft., 3,000 gal. acid, T.D. 2,901 ft.

Posey County

Wildcat: T. B. Dirickson et al 1 Slygh, S½ SE NW NW 23-6s-13w, dry, Ste. Genevieve 2,735 ft., St. Louis 2,930 ft., T.D. 2,940 ft.
Johnson O. & R. 1 Spencer, SE SE SE 26-7s-15w, dry, H.F.W. 2,592 ft., T.D. 2,771 ft.

Spencer County

Wildcat: Doris McPherson 1 Nichols, SW NW NW 10-8s-6w, dry, T.D. 1,075 ft.

Vigo County

Wildcat: Sage & Farley 1 Campbell, S½ NE NW 21-11n-8w, dry, T.D. 3,000 ft.

INDIANA DRILLING REPORT

Daviess County

J. W. Cannon 1 Walker.....N½ SE SE NE 5-2n-3w Spud.

Dubois County

J. C. Howes 1 Eckert....SW NE NW SW 14-3s-3w S.D. 400 ft.

Elkhart County

Headley et al 1 Payser.....SE SE SE 11-38n-4e Spud and S.D.
A. W. Downs 1 Bement.....NW NW SW 12-38n-4e T.D. 690 ft., P.B. 660 ft., S.D.
R. Tamblyn 1 Greene.....NW NW NW 13-38n-4e S.D. 626 ft.

Gibson County

Oleum Pet. Corp. 1 Curd.....SE NW NW SE 5-2s-8w S.D. 600 ft.

Greene County

Midwest et al 1 Good.....W½ NE NW 21-6n-7w Drilling 1,950 ft.

(Continued on Page 193)

Wildcat in Columbia County Showing for Deep Producer

By
GEORGE WEBER

SHREVEPORT, La., May 19.—A new oil discovery became a possibility in South Arkansas as the result of a drill-stem test in a Columbia County wildcat. Another oil show occurred in a shallow Union County wildcat, while a deep wildcat east of Schuler in the same county showed stain and odor and is being closely watched as it approaches the Jones sand of the Schuler field.

In North Louisiana, a Winn Parish wildcat reports a show of gas. A deep test east of Pettit production on the Lisbon structure of Claiborne Parish proved disappointing when the Vaughn sand of the Cotton Valley formation tested salt water.

SUMMARY OF COMPLETIONS

North Louisiana

	No.	Bbl.	Footage
Oil wells: Caddo	2	55	3,079
Pleasant Hill	1	5	3,130
Olla	6	1,186	14,112
Sligo	1	88	3,142
Gas wells: Monroe	1	*1	2,175
Total	11		25,638

Arkansas

Oil wells: Urbana	1	70	3,004
Dry holes: Wildcats	1		7,525
Total	2		10,529

East Texas Border

Oil wells: Smithland	3	79	6,274

*Million cu. ft.

ARKANSAS

The outstanding development of the week was the testing of oil in McAlester Fuel Co. 1 Franks, Columbia County wildcat, located 5 miles east of the Dorcheat field, in 16-18-21. The Cotton Valley formation was topped at 6,335 ft., and a core cut in the formation at 6,910-20 ft. showed recovery of 10 ft., including 3½ ft. of siltstone with spotted oil, and 6½ ft. of porous oil sand. A drill-stem test taken at 6,910-20 ft. showed recovery of 28 stands of 37.7-gravity oil and 42 stands of drilling mud. The testing tool was open for 8 minutes, and ¼-in. top and ½-in. bottom chokes were used. A working pressure of 40 lb. was recorded. Operators are coring ahead below the oil show.

The 1 Franks, although 5 miles from production at Dorcheat, is believed by many to be located on the same structure. The field as precently developed shows a definite uplift to the east, and a contour map of the Smackover producing formation indicates that the currently developed field is the western end of what may prove to be a major reservoir. Seismograph explorations of the area substantiate the conjecture and indicate that the major area of uplift lies east of the present production.

The McAlester wildcat tested oil in the Cotton Valley formation, well above the Smackover oil horizon producing at Dorcheat. The possibility of finding oil saturation in the porous oolitic Reynolds member in the top of the Smackover is therefore considered very good, and results of the test in that horizon will be watched with great interest. Should the wildcat prove an extension to Dorcheat, the field will rival the Magnolia field, the largest oil reserve discovered in Arkansas since Smackover.

Three miles east of the Schuler field, Union County, another deep wildcat is of current interest. Crescent Drilling Co. 1 Burns, 13-18-17, was last reported preparing to core at 7,446 ft., believed to be the top of the Jones sand, principal producing horizon in the Schuler field. A care taken at 7,192-7,207 ft. contained 1 ft. of lime and shale, 4 ft. of sand with stain and odor of oil and 6 ft. of sand and sandy lime, with no shows.

Contours on the Jones sand at Schuler show a secondary uplift on the southeast, and the elongated extension of the field to the southeast has led geologists to believe that a second production area may lie southeast of the field, separated from it by a shallow saddle. Developments at the Crescent test in the next few days may prove or disprove this theory.

East of El Dorado, a shallow Union County wildcan, Sam Sebersky 1 Union Saw Mill Co., 15-18-14, has a reported show of oil at 2,230 ft. in the top of the Nacatoch sand. In the Warnock Springs area, a second deep Smackover test failed to find production as the Phillips Petroleum Co. abandoned 1 R. S. Warnock, 1-17-20. The test was located 2 miles north of the Magnolia field and 1¼ miles south of a dry test drilled by the Standard Oil Co. of Louisiana.

The Smart sand, deep discovery in the Stephens field, Columbia County, has produced a total of 1,000 bbl. of 31-gravity oil to date. The test is not officially completed but has been making a small amount of oil since late last month. The Smart sand was discovered by the Crow Drilling Co. in 1 Smart which tested oil at the new level but has not yet been completed as a commercial production.

ARKANSAS COMPLETIONS

Wildcat—Columbia County

Phillips Pet. Co. 1 R. S. Warnock, Jr., SW NW 1-17-20 T.D. 7,525 ft., drill stem stuck 7,473-7,525 ft., tested salt water, dry.

Urbana—Union County

Marine Oil Co. 7-E Thompson....NW NW NE 10-18-13 70 bbl., 18/64-in. choke, T.P. 350 lb., C.P. 825 lb., T.D. 3,004 ft., 7-in. casing 2,991 ft.

ARKANSAS DRILLING REPORT

Clark County

Coker Christman & Grieves 1 Williams ..... NE NE NE 7-11-20
T.D. 1,689 ft., awaiting orders.

Columbia County

Fitzwater & McClerkin 1 C. C. Smart ..... NE NE NE 14-15-20
Testing, T.D. 3,434 ft.

McAlester Fuel Co. 1 Franks.....SE SE 16-18-21
Cored 6,910-20 ft., recovered 10 ft., 3½-ft. silt stone, spotted oil, 6½ ft. porous oil sand, D.S. test 6,910-20 ft., 8 minutes, ¼-in. choke top, ½-in. bottom, recovered 28 stands oil and 42 stands of drilling mud, W.P. 40 lb., coring ahead.

Faulkner County

Cato Oil Co. 1 R. R. Harrell.....SE SW 35-4n-12w
S.D. 3,625 ft.

Jefferson County

Patterson & Stratton 1 F. & D. Stratton..... SE NW NE 35-6s-9w
T.D. 720 ft. (corrected), reported 11 ft. oil sand, set 8-in. casing at 710 ft., tested fresh water.

Lincoln County

J. S. Moore 1 Payne.....E½ SE 18-10s-7w
First report.

Lonoke County

A. V. Riley 1 J. T. Gunter....SE SE SE 17-5n-10w
S.D. 3,045 ft.

Ouachita County

Arkansas Fuel Oil Co. 1 McGaughy..NW NW 6-15s-18w
Drilling shale 576 ft.

Prairie County

Alvin E. Stark 1 Fidelity Mutual ..NE SW 16-2n-6w
T.D. 1,103 ft., testing sand 1,099-1,103 ft.

Union County

Crescent Drlg. Co. 1 Burns.....NE SW 13-18-17
Coring 7,446 ft.

Sebersky et al 1 U.S.M.....SE NE NE 15-18s-14w
Coring 2,305 ft.

NORTH LOUISIANA

The Wilcox play of La Salle and surrounding parishes continued slow during the past week, with several tests held up because of high water. In Winn Parish, the Sells Petroleum Co. reports a show of gas below 1,800 ft., and is drilling ahead below 2,650 ft. Six new wells were completed in the Olla field during the past week and drilling continues in the Little Creek, Nebo and Summerville fields.

LISBON TEST.—The Big West Drilling Co. 1 Patton estate, located on the southeast edge of the Lisbon Pettit field encountered the Vaughn sand last week, but tested salt water. This proves a disappointment, for the deep test is drilled to explore the deep possibilities of the Cotton Valley and possibly the Smackover formations. The Vaughn sand, first opened to production in the Lisbon Exploration Co. 1 Vaughn in the north portion of the Lisbon field, and later, the Caruthers et al 1 Burgess-Simmons, tested oil and gas in other Cotton Valley sections. The Big West test is located 2½ miles southeast of the Caruthers test.

NORTH LOUISIANA COMPLETIONS

Sligo—Bossier Parish

Triangle Drlg. Co. 1 Murff unit.....SW SE 18-17-11
Pumped 88 bbl., T.D. 3,142 ft., 5½-in. casing 3,128 ft., 2,500 gal. acid.

Caddo—Caddo Parish

Davis & Hart 6-B Muslow.....SE SE NW 32-21-15
Pumped 30 bbl., T.D. 1,524 ft., 4,000 gal. acid, 7-in. casing 1,381 ft.

S. Reele 1 Lavine .....SE NE SE 12-20-16
Pumped 25 bbl., T.D. 1,554 ft., 4,000 gal. acid, 6⅝-in. casing 1,411 ft.

Pleasant Hill—De Soto Parish

George L. Pace 1-B Logan Oil Co. SW NW SW 16-10-12
5 bbl. oil, est. 500,000 cu. ft. gas, open tubing, T.D. 3,288 ft., P.B. 3,130 ft., 5½-in. casing 3,114 ft.

Olla—La Salle Parish

Arkansas Fuel Oil 13-C Tremont.....NE NE 3-9n-2e
223 bbl. oil, 17 bbl. salt water, 20/64-in. choke, T.P. 155 lb., C.P. 225 lb., T.D. 2,422 ft., 7-in. casing 2,415 ft., Wilcox.

Arkansas Fuel Oil 12-C Tremont.....NW SE 3-9-2
Pumped 90 bbl. oil, 10 bbl. salt water, T.D. 2,125 ft., 7-in. casing 2,106 ft., perf. 2,047-60 ft., Wilcox.

Carter Oil Co. 1 J. B. Cockerham et al unit..... SW SW 24-10-2
432 bbl. oil, 48 bbl. salt water, 21/64-in. choke, T.P. 120 lb., C.P. 450 lb., T.D. 2,313 ft., 7-in. casing 2,313 ft., perf. 2,206-15 ft., Wilcox.

Placid Oil Co. 66 La. Central 35-10-2e
117 bbl. oil, 33 bbl. salt water, 24/64-in. choke, T.P. 40 lb., C.P. 230 lb., flow valves, T.D. 2,422 ft., 7-in. casing 2,391 ft., perf. 2,194-98 ft., Wilcox.

Placid Oil Co. 76 La. Central.....NW NW 7-10-3e
180 bbl. oil, 20 bbl. salt water, gas lift, open tubing, T.D. 2,100 ft., 7-in. casing 2,399 ft., perf. 2,202-06 ft., Wilcox.

Placid Oil Co. 86 La. Central ..... NW SE 26-10-2
144 bbl. oil, 6 bbl. salt water, T.P. 180 lb., C.P. 500 lb., T.D. 2,430 ft., 7-in. casing 2,426 ft., perf. 2,222-30 ft., Wilcox.

Monroe—Union Parish

N. & W. Corp. 1 Pinckard .....NE NW 33-21-3e
1,000,000 cu. ft. gas, R.P. 1,010 lb., T.D. 2,175 ft., 6⅝-in. casing 2,073 ft., Monroe gas rock.

NORTH LOUISIANA DRILLING REPORT

Bossier Parish

George D. Stevens 1 Bellevue Land Co..... NW SW SE 27-20-11
Drilling 1,015 ft.

Caldwell Parish

Big West Drlg. Co. 1 A. Lowe.....SE SE 36-12n-3e
Location.

Catahoula Parish

Carter Oil Co. and Phillips Pet. Co. 1-B Tensas Delta SE NW 15-5n-5e
Rigging up.

Claiborne Parish

Harold A. Wright 1 Rainach.....SW NE 16-22-5
S.D., awaiting orders, 5,510 ft.

De Soto Parish

G. H. Neighbors 1 Bufkin .....NE SE NW 11-10-11
Drilling sand 2,170 ft.

J. E. Stack et al 1 Cook.....NW NE 32-13-14
Set 7-in. casing 2,890 ft.

Grant Parish

Bert Fields et al 1 McManus.....SW NE 8-8n-4w
Derrick up.

La Salle Parish

Delta Drlg. Co. 1 Hughes ..... NE NE SW 22-8-1e
Set 5½-in. casing 1,509 ft., old T.D. 4,092 ft.

Milton J. Houston et al 1 Gross.....NE NE 19-8n-3e
S.D. 1,637 ft.

M. L. Meredith 1 Grey .....NE NE 36-8-2e
S.D. 50 ft.

H. R. Scivally, Tr. 1 Tensas Delta .. SW NE 12-6n-4e
10¾-in. casing 571 ft., drilling shale 2,955 ft.

Lincoln Parish

Big West Drlg. Co. 1 Patton est. E½ W½ SE 7-20-4w
Drilling shale and sand 8,723 ft.

Natchitoches Parish

Clark & Cowden Drlg. Co. 1 Pierson..... NW NE SW 27-8n-6w
First report.

Sabine Parish

K. E. Merren 1 Nona Mills Lumber Co. ..... SW SW NE 28-3n-12w
S.D., high water 1,280 ft.

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DALE SHAPPELL
Box 3038, Phone 8242
Wichita Falls, Texas

LEROY HORTON, Superintendent
Crude Oil Contracting Co.
603 East Oak, Phone 144
Cushing, Oklahoma

THE DEHYDRO COMPANY
TULSA, OKLAHOMA

J. E. Watts 1 Cook Land Co. . . . . W½ SW NE 27-10-11 T.D. 3,475 ft., S.D., awaiting orders.

Union Parish

Carter Oil Co. 1 H. H. Farley et al . . NE SW 10-20n-1w T.D. 4,094 ft., cutting out stuck drill pipe.

Winn Parish

Sells Pet. Co. 1 Feazel et al . . . . . C N½ 26-13-3w 10¾-in. casing 266 ft., drilling shale 2,624 ft.
Nate Wiseman 1 Quinn . . . . . Irreg. Sec. 38-9-6w S.D. 2,604 ft., awaiting orders.

EAST TEXAS BORDER COMPLETIONS

Smithland—Marion County

R. S. Kirby 7 Burks, G. Coore Sur., pumped 14 bbl., T.D. 2,305 ft., 5½-in. casing 2,269 ft.
H. T. Manning, Tr. 1 Minnie Gray, L. Needham Sur., pumped 50 bbl., T.D. 2,352 ft., 5½-in. casing 2,275 ft.
Sloan Wells 1 Ida Burr, M. G. Nall Sur., pumped 15 bbl. oil, 100 bbl. salt water, T.D. 1,617 ft., 6-in. casing 1,507 ft.

EAST TEXAS BORDER DRILLING REPORT

Bowie County

Normandie Oil Co. 1 E. Powell, John S. Herring Sur., T.D. 4,215 ft., S.D., awaiting orders.

Cass County

British American Oil Prod. Co. 1 East Texas Iron Assn., L. Moren Sur., S.D. 4,300 ft.
W. A. Patterson 1 Orr, G. W. Morris Sur., S.D. 2,230 ft.

Marion County

A. H. Richardson 1 T. G. Allen, Robert Potter Sur., T.D. 2,600 ft., twisted off drill stem, fishing.

Sabine County

Sturm & Womack 1-A Keith, L. Grace Sur., S.D., T.D. 6,545 ft.

San Augustine County

Roper & Todd 1 Long Bell Lumber Co., N. Hyden Sur., S.D., T.D. 3,021 ft.

North Central Texas Fields

(Continued from Page 176)

in. choke, est. 150 bbl. daily, 3,825-99 ft.
Kriss & Buzzard 3 Hughes, 8 bbl., pumping, 595-600 ft.
Helmerich & Payne 1 Jones "A," 50 bbl. oil and 50 bbl. water, pumping, 750 gal. acid, top Caddo 4,624 ft., pay 4,632-42 ft.
Falls: Bridwell 2 Falls, 25 bbl., pumping, 2,000 gal. acid, 1,123-37 ft.
Miscellaneous: John Webb 2 Jehlik, 85 bbl., flowing, 1,111-19 ft.
B. C. Gilmore 1 Williams, 4 bbl., pumping, 720-23 ft.
Petroleum Producers 1 Koester, 260 bbl., pumping, 1,119-25 ft.
Wildcat: J. R. Jones 1 Jones, Sec. 103, Jefferson Co. Sch. Lds. Sur., dry at 1,187 ft.

Clay County

Miscellaneous: Sussex Oil 24 Glasgow, 250 bbl., pumping, naturally, 1,059-92 ft.
George Golden 2 Enyart, 5 bbl., pumping, 283-91 ft.
George Golden 2 Hansard, 64 bbl., pumping, 1,119-48 ft.
Stayton Oil 3 McGregor, 25 bbl., pumping, 1,128-39 ft.
Stayton Oil 4 McGregor, 30 bbl., pumping, 1,145-60 ft.
Ross: Continental Oil 2 Ross, 99 bbl. in 3 hr., ¾-in. choke, 16,000 gal. acid, est. 400 bbl. daily, 5,476-5,516 ft.
Antelope: Shell 10 Coburn, 144 bbl. in 8 hr., 2-in. casing outlet, naturally, est. 350 bbl. daily, 3,203-18 ft.

Cooke County

Miscellaneous: Seitz, Comegys & Seitz 13 Poteet, 9 bbl., pumping, 21-qt. shot, 1,344-53 ft.

Denton County

Wildcat: C. H. Cannon 1 Aetna Life Co., S Yoachum Sur., Abst. 1439, dry at 1,508 ft.

Jack County

Miscellaneous: B. C. Gilmore 1 Patton, dry at 554 ft.
Bryson: George Weber 2 Brannon-Smith, 2 bbl. daily, 294-314 ft.
Wildcats: Alma Oil 1 Dees, George Taylor Sur., Abst. 884, top Caddo 4,494 ft., dry at 4,885 ft.
Harper & McClintock 1 Kinder, Sec. 2667, T.E.&L. Sur., dry at 2,205 ft.

Montague County

Nocona: J. M. Hawley 4 Bouldin, 10 bbl. daily, pumping, 23-qt. shot, 797-812 ft.
Claymont Oil 1 Bouldin-Crow, 10 bbl. daily, pumping, naturally, 814-822 ft.
Wildcats: Redmon Bros. 1 Hardy, Fielding Secrest Sur., Abst. 665, dry at 2,447 ft.
Sinclair Prairie 1 Clingingsmith, Sec. 149, Jose Olabarri Sur., Abst. 579, 145 bbl. in 3 hr., open tubing, naturally, est. 600 bbl., conglomerate pay 6,119-31 ft.
Benson & Benson 1 Seay, J. P. Owensby Sur., Abst. 578, 244 bbl., pumping, naturally, conglomerate pay 5,752-62 ft.

Wichita County

Miscellaneous: Dudley & Fisher 2 Hardin, dry at 605 ft.
Akin, Dimock & Costley 6 Dodson, 45 bbl. daily, pumping, naturally, 1,320-24 ft.
Akin, Dimock & Costley 4 Oates, 30 bbl. daily, pumping, naturally, 1,288-1,300 ft.
F. W. Merrick 1 Dorris, 166 bbl. daily, pumping 120-qt. shot, 4,101-34 ft.
K.M.A.: Mogren & Anderson 17 Mertens, 2 bbl. daily, pumping, 810-23 ft.
Tide Water and Perkins & Cullum 29 Pettit, 15 bbl. in 1 hr., ¾-in. choke, est. 150 bbl. daily, 3,688-3,790 ft.
Shell and Phillips 4 Preston "B," 105 bbl. in 3 hr., ¾-in. choke, 35-qt. shot, est. 275 bbl. daily, 3,954-68 ft.
K.M.A.-Deep: Cochran & Cain 1 Bradley, 71 bbl. in 3 hr., ½-in. choke, est. 270 bbl. daily, top Ellenburger 4,480 ft., pay 4,480-94 ft.
Shell 21 Griffin, 155 bbl. in 3 hr., ¾-in. choke, est. 500 bbl. daily, top Ellenburger 4,436 ft., pay 4,455-81 ft.

Wilbarger County

Miscellaneous: W. B. Omohundro 5 Waggoner, 3 bbl. oil and 6 bbl. water, pumping, 1,091-95 ft.
Fargo: Amerada 1 Parker, 87 bbl. in 3 hr., 1-in. choke, naturally, est. 375 bbl. daily, 3,931-48 ft.
Wildcat: A. E. Blair 1-A Scott, Sec. 26, Blk. 26, Blk. 13, H.&T.C. Sur., dry at 737 ft.

Young County

Olney: Pemeta Oil 16 Johnson, 4 bbl. daily, pumping, 520-30 ft.
Pemeta Oil 17 Johnson, 6 bbl. daily, pumping, 540-54 ft.
Pemeta Oil 18 Johnson, key well at 507 ft.
W. F. Collins 2-A Hawkins, dry at 530 ft.
L. T. Burns 2 Bloodworth, dry at 952 ft.
L. T. Burns 12 Rogers, dry at 917 ft.

NORTH TEXAS WILDCAT REPORT

Archer County

W. B. Hamilton 22 Cartwright, 660 ft. from W and S lines, James Webb Sur., Abst. 664, T.D. 5,211 ft., P.B. 5,164 ft., 60-qt. shot 5,149-61 ft., swabbing and cleaning out, est. 30 bbl. oil daily, putting on pump.
Bass & Dillard 1 McGregor, 467 ft. from N and W lines, E. Goodwin Sur., Abst. 1135, 6,000-ft test, fishing 5,055 ft.

Clay County

Bridwell Oil 1 Myers (old well drilling deeper), Charleton Thompson Sur., Abst. 444, top Mississippian 5,997 ft., old T.D. 6,065 ft., derrick, to drill deeper.
Shell 9 Henderson, SW SW Sec. Sec. 2605, T.E.&L. Sur., Antelope field, top Mississippian lime 5,662 ft., drilling 5,910 ft.
Gulf 1 C. W. Scaling, NW NW Sec. 31, T.&N.O. Sur., Abst. 685, 6,000-ft. test, flowed 183 bbl. oil in 14 hr. from 5,600-14 ft., still testing.
L. T. Burns 1 Southerland, NE cor. of 100 acres of Sec. 63, J. H. Belcher Sur., 5,500-ft. test, top Caddo 5,322 ft., T.D. 5,386 ft., P.B. 4,437 ft., swabbed est. 30 bbl. oil and 4 bbl. water per day, S.D.
L. T. Burns 1 Fred Wines, 593 ft. from N and 476 ft. from E lines of Sec. 1, Halsell Subd. 1, 5,500-ft. test, drilling 4,660 ft.
Bridwell Oil 2 Meyers, 3,350 ft. from W and 2,185 ft. from N lines, Thompson Sur., Abst. 444, drilling 5,076 ft., 6,000-ft. test.

Cooke County

Cochran & Cain 1 Drane, 2,720 ft. from W and 150 ft. from S lines E. Langford Sur., Abst. 566, 1,800-ft. test, first report.
Cochran & Cain 2 Drane, 3,020 ft. from W and 150 ft. from S lines of E. Langford Sur., Abst. 566, 300 ft. E of No. 1, first report.

Grayson County

R. W. Talbot 1 Jewell, SW cor. 159-acre tract in William Allen Sur., Abst. 15, 5,000-ft. test, drilling 2,365 ft.

Hood County

Aztec Oil 1 Gallagher, SW SE Robert Alway Sur., 3,000-ft. test, drilling 2,680 ft.

Montague County

Chapman & McFarlin 1 Mose Fowler, R. M. Davis Sur., Abst. 181, location.

Throckmorton County

Rathke Oil 1 Swagerty, 495 ft. from N and 746 ft. from E lines of SW Sec. 258, B.B.B.&C. Sur., 5,000-ft. cable-tool test, drilling 4,548 ft.

Wichita County

King Oil and Perkins & Cullum 1 Wells, 2,353 ft. from W and 4,230 ft. from N lines, Lot 23, J. A. Ventross Sur., Abst. 103, 5,000-ft., or Ellenburger lime test, location.

Wilbarger County

J. B. H. Henderson 1 Waggoner, NW NW NW Sec. 2, Blk. 13, H.&T.C. Sur., 2,400-ft. test, location.
O. H. Hammer 1 A. V. Shelton, NW NW Sec. 16, Blk. 11, H.&T.C. Sur., 4,500-ft. test, S.D. 524 ft.
Wilcox Oil & Gas 1 Waggoner, 330 ft. from S and E lines, SW Sec. 43, Blk. 2, H.T.C. Sur., 5,000-ft. test, drilling 4,410 ft.

Young County

Horwitz & Oldom 1 Graham, SE cor. Sec. 2912, T.E.&L. Sur., 5,000-ft. test, first report.

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WEST CENTRAL TEXAS WILDCAT REPORT

Brown County

Guyle Greynolds 1 Crownover, 467 ft. from S and E lines Sec. 26, B.B.B.&C. Sur., 3,000-ft. test, top Caddo 2,465 ft., drilling 2,486 ft.

Central Tex. Gas 1 E. S. Smith, NE cor. of W 199 acres of S 291 acres of Wm. Guyman Sur. 86, 2,000-ft. test, S.D. 1,868 ft.

H. P. Evans 1 Starkey, SE SE Sec. 3, H.C. Walker Sur., 1,200-ft. test, S.D. 150 ft.

Callahan County

Slay & Hyer 1 Hennessy, NE SW Sec. 83, B.B.B.&C. Sur., S.D. 1,820 ft.

Clark & Young 1 Ditler Bros., SE NE SE Sec. 54, L.A.L. Sur., 750-ft. test, 300 ft. S of No. 2 which made discovery well at 441 ft. for 10 bbl. daily.

Coleman County

J. O. Hart & Sons 1 Brooks-Peyton, SW Lot 7, Samuel B. Mixon Sur., Abst. 522, 1,350-ft. test, drilling 1,009 ft.

West Coast Prod. Corp. 1 Morris, SW cor. of NE 160 acres, J. Greenwood Sur. 304, 1,000 gal. acid, pumped 12 bbl. oil in 12 hr.

Comanche County

W. G. Forson 1 T. G. Sliger, SW cor. of tract in John Harrison Sur., Abst. 433, 3,500-ft. test, first report.

Hamilton County

Lone Star Gas 1 Burks, 1,654 ft. from NE and 1,175 ft. from NW lines James Hays Sur. 16, Pat. D-705, 3,000-ft. test, surface casing 158 ft.

Jones County

S. B. Roberts 1 Cooper, SE SE SW Sec. 20, Blk. 15, T.&P. Sur., 4,000-ft. test, T.D. 4,919 ft., treated 1,000 gal. acid, made 8 B.O. in 24 hr.

W. W. Fondren 1 C. P. Rogers, 126-acre tract in N½ Sec. 32, Blk. 18, T.&P. Sur., 3,100-ft. test, show oil in lime 2,951-55 ft., oil sand 2,955-57 ft., filled 2,000 ft. with oil in 3½ hr., swabbed 4,000 ft. oil in 1 hr., cementing casing for completion.

J. J. McMahon 1 Miller, 400 ft. from S and 330 ft. from E lines Lot 13, Warren Subd. 125, S.D. 1,920 ft.

Merry Bros. & Perrini and Butler and Horne Drilling Co. 1 Collins, Lot 25, Godwin & Warren sub., drilling 2,205 ft.

T. J. Coyne 1 L. E. Clyburn, NW cor. tract in Lots 24 and 27, Holt subd. of Henry Millard Sur. 243, 2,000-ft. test, first report.

Mills County

C. D. Lane 1 Egger, 2,078 ft. from N and 450 ft. from W lines Sec. 4, Wm. Maynes Sur., 3,500-ft. test, S.D. 1,059 ft.

Palo Pinto County

Hickok Prod. and Reynolds 1 J. R. Halsell, 467 ft. from S and W lines Sec. 92, B.B.B.&C. Sur., Abst. 105, 5,500-ft. test, coring oil 4,630 ft.

P. F. Cole 1 Crawford, 467 ft. from W and 90 ft. from N lines Sec. 888, T.E.&L. Sur., 5,000-ft. test, drilling 1,665 ft.

Parker County

J. L. Higginbotham 1 Wheeler, SE cor. J. B. Brannon Sur., Abst. 1928, 5,000-ft. test, drilling 1,140 ft.

Shackelford County

Aragon Oil 1 Walls Pasture, SW cor. Sec. 39, B.A.L. Sur., 4,000-ft. test, drilling 1,274 ft.

J. W. Keys 1 Smalley, SW SE Sec. 13, E.T. Sur., 900-ft. test, drilling 297 ft.

Kleiner & Dickey Bros. 1 Miller, NW cor. Sec. 571, T.E.&L. Sur., 750-ft. test, first report.

R. H. Roark 1 Elliott, SE SW SE Sec. 9, L.A.L. Sur., 5,000-ft. test, first report.

T. F. Morrow 1 Dyer, 1,050 ft. from N and 150 ft. from E lines Sec. 73, Blk. 12, T.&P. Sur., 1,500-ft. test, first report.

Somervall County

M. E. Davis 1 Cousins, 457 ft. from SE and NE lines of tract in John Echols Sur., 7,500-ft. test, reaming 1,276 ft.

Stephens County

C. Andrade III 1 Walls Pasture Co., NE cor. Sec. 13, O.A.L. Sur., 3,800-ft. test, drilling 1,731 ft.

Stonewall County

Leader Oil 3 Carlisle, 2,136 ft. from N and 2,127 ft. from E lines of Sec. 292, Blk. D, H.&T.C. Sur., coring 5,255 ft.

Taylor County

Ce-Beth Oil 1 City of Abilene, south shore of Lake Abilene on city property, 4,000-ft. test, recovered fish, coring oil 2,605 ft.

Permian Basin

(Continued from Page 183)

NORTHERN WEST TEXAS WILDCAT REPORT

Andrews County

Magnolia 1 Ralph, NE cor. Sec. 20, Blk. 38-A, P.S.L. Sur., spudding.

Phillips 1 University-Drews, NW NE Sec. 32, Blk. 10, University Lands Sur., drilling 7,852 ft.

Mascho Oil 1 Fisher, NE NE SE Sec. 16, Blk. 36-A, P.S.L. Sur., drilling 3,760 ft.

Mascho Oil 1 University, Sec. 11, Blk. 13, University Sur., 6½ mi. NW of 1 Fisher, 8⅝-in. 1,798 ft.

Mascho Oil 1 Univ.-Gulf, NW cor. Sec. 19, Blk. 9, University Sur., first report.

Borden County

M. L. Richards 1 W. R. Dunn, SW NE Sec. 307, Blk. 97, H.&T.C. Sur., 3,200-ft. test, T.D. 300 ft.

Cochran County

George Livermore 1 Wright, old T.D. 4,997 ft., S.D. 6,621 ft.

O'Neal Drilling Co. 1 Wright, NE cor. Labor 12, Lge. 60, Martin C.S.L. Sur., 3 mi. N of Dean area, S.D. 4,983 ft.

Gaines County

Amon G. Carter 4-D Wasson, NW SE Sec. 50, Blk. AX, P.S.L. Sur., drilling 10,500 ft.

Hale County

Humble 1 Byrd, SE SE NE Sec. 17, Blk. K, E.T.R.R. Sur., 9,000-ft. test, drilling 4,381 ft.

Martin County

Wiggins & Hyde 1 Stinson & Burley, NE SW Sec. 4, Blk. 38, T.&P. Sur., 5,000-ft. test, first report.

TEXAS PANHANDLE

AMARILLO, Tex., May 19.—Continuing the district's renewed drilling program, new locations for the Texas Panhandle the past week totaled 18. This is considerably below last week's total of 31, however, it brings the aggregate total of new locations since the first of the year to 341.

Completions in the field totaled 14, there being 13 oil wells for a new daily initial of 3,138 bbl., and one gas well for an initial of 10,600,000 cu. ft. daily.

PANHANDLE COMPLETIONS

(24-hr. pumping, gages)

Carson County

Cities Service 2-C Burnett, 90 bbl., 100-qt. shot, 3,151-72 ft.

Gray County

Bradshaw Oil 7 Pope, 104 bbl., 560-qt. shot, 3,288-3,301 ft.

King Oil 1 Archer, 232 bbl., 120-qt. shot, 3,180-3,287 ft.

Phillips 5-A Benton, 105 bbl., 320-qt. shot, 3,170-3,-264 ft.

Hutchinson County

Cree & Hover 12 Harvey, 145 bbl., 135-qt. shot, 3,020-59 ft.

Kewanee Oil & Gas 54 Lewis, 423 bbl., 450-qt. shot, 2,931-3,007 ft.

Paloma Oil & Gas 9 Lewis, 229 bbl., 410-qt. shot, 2,885-3,000 ft.

Phillips 55 Cockrell, 184 bbl., 400-qt. shot, 2,880-2,991 ft.

Phillips 59 Cockrell, 210 bbl., 400-qt. shot, 2,978-3,-090 ft.

Phillips 4 Lizzie, 295 bbl. oil and 47 bbl. water, 260-qt. shot, 3,500 gal. acid, 3,165-3,218 ft.

Travelers Oil 12 Haile B, 504 bbl., 410-qt. shot, 2,970-3,034 ft.

Shell Oil 20 Harvey B, 409 bbl., 4,000 gal. acid, 160-qt. shot, 3,015-78 ft.

Moore County

Texhoma Natural Gas 2-M Haile, 10,600,000 cu. ft. gas, natural, 2,680-3,060 ft.

Wheeler County

Clark 3 Sloss, 207 bbl., natural, granite wash pay 2,135-38 ft.

SOUTHEAST NEW MEXICO COMPLETIONS

Eddy County

Artesia: Flynn, Welch & Yates 76 State, SE SW 29-18s-28e, 10 bbl. at 2,013 ft.

Skelly: Emperor 11-A Puckett, NE SE 24-17-31, 200 bbl. at 3,930 ft.

Emperor 1-B Puckett, SW SW 24-17s-31, 25 bbl. at 3,965 ft.

Wildcat: Long 1 Prichard, NE NE 18-20-26, location abandoned.

Lea County

Maljamar: Cockburn 1-B Pearsall, NW NW 34-17-32, 612 bbl. in 18 hr. at 4,270 ft.

Rhodes: Krupp & Flaherty 2-B Moberley, SW NE 21-26-37, 45 bbl. an hr. at 3,260 ft.

SOUTHEAST NEW MEXICO DRILLING REPORT

Chaves County

Elliott 1 State ..... NW NE 16-11-31
Drilling by tools, 3,915 ft.

Martin 1 Stephens ..... NW NE 22-15-29
Drilling 3,420 ft.

Montgomery 1 Purcell ..... SW NW 13-11-26
Drilling 1,581 ft.

Eddy County

Anderson 1 Root ..... NW SE 12-17-29
Drilling 1,045 ft.

H. Aid 1 Wentz ..... SW SE 24-17-28
Drilling 1,220 ft.

Jones & Yates 1 Pickrell ..... SW SW 5-19-26
Drilling 890 ft.

Whiting Grant 1 Howell ..... NW SE 32-30-25
Drilling 347 ft.

Lea County

J. W. Brown 1 State ..... Lot 4, 4-16-35
Drilling 4,112 ft.

Fullerton 1 State, drilling 1,340 ft., to run casing.

Helmerich & Payne 1 Phillips-State ..... NW SW 3-14-38
5,800-ft. test, digging water well.

Schermerhorn-Winston 1 State ..... NE NW 32-24-27
Waiting on cement 134 ft.

F. Turner 1 Webb-Govt. ..... SW NW 31-16-37
Drilling 4,965 ft.

Illinois Fields

(Continued from Page 186)

Pumped 50 bbl. oil and 50 bbl. water from Benoist, squeezed, waiting on cement.

Compton & Fotiades 1 W. C. Gray NE SW SW 21-4s-14w
Set 10-in. 85 ft., drilling 330 ft.

French & Lavender 1 A. C. Metcalf ..... SW SW SE 31-3s-14w
Rigging up rotary.

Whiteside County

J. S. Feltus 1 Hopkins ..... NW NE NE 35-21n-6e
Drilling 615 ft.

J. F. Morse 1 Sheldon ..... NW SW NW SE 11-19n-7e
Drilling 1,057 ft.

Williamson County

Wiser Oil 1 U. S. Coal & Coke NW NW NW 15-8s-2e
Glen Dean 1,966 ft., Hardinsburg 2,038 ft., Golconda 2,122 ft., Barlow 2,292 ft., Cypress 2,296 ft., Cypress sand 2,317 ft., S.D. 2,772 ft.

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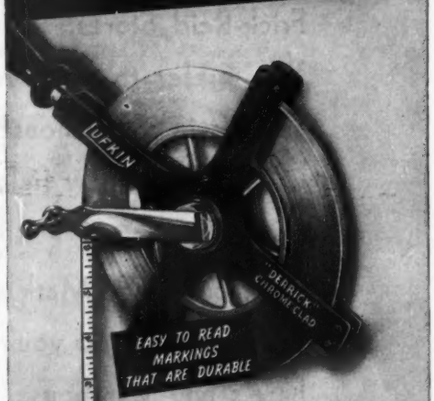

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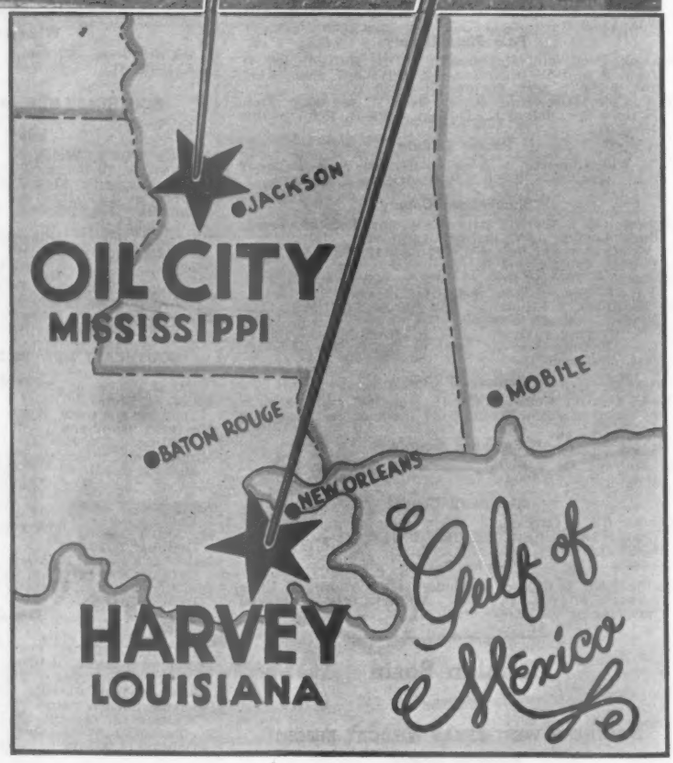

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TULSA, OKLAHOMA

Interest in Wildcats Increases With Good Oil Showings

By R. MARNE SANFORD

DALLAS, Tex., May 19.—Favorable structural conditions and shows of oil in several wildcat tests throughout the district have built expectations for more discoveries in the eastern Texas counties. Already this year wildcatting in the district has netted greater returns than any other one full year in the past 5 years.

SUMMARY OF COMPLETIONS

	No.	Bbl.	Footage
Oil wells: East Texas	12	566	43,060
Hawkins	9	1,632	43,502
Other fields	2	625	16,778
Gas wells: Fields	1	*235	5,268
Dry holes: Wildcats	5	.....	13,955
Total	29	.....	122,563

*Million cu. ft.

Newest wildcat to gain prominence in the district is the test south of Canton in Van Zandt County. It is Hickok & Reynolds 1 Brown, Leander Smith Survey. The test is drilling below 3,690 ft. and reported checking about 171 ft. higher structurally, than the operator's 1 Dubose, Stockwell Survey, 2 miles to the northeast, which was drilled in 1939. No. 1 Brown topped the Austin chalk at 3,205 ft., with elevation of 466 ft., datum point of minus 2,739 ft. The failure topped the Austin chalk at 3,465 ft. and with an elevation of 555 ft. established a datum point of minus 2,910 ft.

A wildcat in Freestone County centered considerable attention as the Woodbine sand was believed topped. It is Carter-Gragg Oil 1 Robert Mims, Lyons Survey, wildcat on the Butler dome in the southeastern part of the county. It was reported coring ahead below 5,197 ft. with 20 ft. of sandy shale from 5,177-97 ft. The test based the Austin chalk at 4,760 ft. and has found no solid sand body yet, however, the sandy shale was believed an indication of the top of the Woodbine section.

In Navarro County a prospective discovery well of 2 weeks ago is still testing. It is the L. T. Davis 1 fee, Jordan Survey, a mile southwest of the Bazzette field. When first believed a producer 2 weeks ago the well was thought to have cut the fault in the area and to have found a new oil section separate from that of the Bazzette field. On last gages the well showed 500,000 cu. ft. of gas daily with a considerable volume of salt water. Show of oil was previously found in the Woodbine sand section drilled from 3,080-86 ft., total depth. The last flow was through ¼-in. choke under 300 lb. of tubing pressure.

In Smith County the prospective discovery of last week, Ross Sears 1 J. F. Pool, George May Survey, 6 miles southwest of Henderson, is still shut down for title curing with the plug undrilled. The test is reported to have shown 150 ft. of oil and gas-cut drilling fluid on a 10-minute test from saturation in the Woodbine sand from 4,052-60 ft. Definite date for drilling plug has not been indicated by the operator.

Chapel Hill Field Extension

Indications for more development on the southwest flank of the large Chapel Hill structure were seen following the completion of two extension wells and the staking of several further outpost locations. Newest producer is the Sun 1 Dickerson, Arnold Survey. In 15 hours following treatment with 4,000 gal. of acid, the well flowed 331 bbl. of oil from perforations in casing from 8,214-35 ft. opposite the Pettit lime. The location is about ½ mile south of Sun 1 A. R. Dickerson, Holden Survey, completed only a few weeks ago as the first Pettit lime oil producer on the flank of the structure. That well found only fair porosity and made 60 bbl. of oil daily on gas lift.

The Sun company late in the week announced that development would continue in the southwest extension area. Announcement for a new drill site was made as the company's 1 V. L. Shofner, 660 ft. from the west and 570 ft. from the south lines of a 79-acre tract in both the Robert Andrews and the James Doughlas surveys. It is about ½ mile south of the new completion this week in the area. The unitizing of acreage in the area, together with the acquisition of tracts by new operators for the field, indicate that even more drilling for the new area may be seen within the coming few weeks.

EAST TEXAS FIELD COMPLETIONS

(1-hr. gages)

Gregg County

Longview area: General American 20 Bingham, 50 bbl., 3,508-20 ft.
Shell 9 Saulter, 55 bbl., 3,669-3,732 ft.
Sinclair Prairie 24 Lawson, 70 bbl., 3,506-92 ft.
Cox & Hamon 20 Rodden, 60 bbl., 3,604-32 ft.
Kilgore area: Houston Oil 7-A Hughey, 60 bbl., 3,485-3,535 ft.
C. C. Julian 12 England, 34 bbl., 3,551-88 ft.
Magnolia 14 Hale, 5 bbl., 3,544-70 ft.
Tex-Canadian Oil 3 Watson, 70 bbl., 3,558-65 ft.
Tide Water 38 Hughey, 75 bbl., 3,486-92 ft.
Tide Water 39 Hughey, 40 bbl., 3,467-79 ft.

Rusk County

Kilgore area: C. A. Everetts 2-A Christian, 45 bbl., 3,745-60 ft.
Joiner area: Tex-Canadian Oil 14-A-B Frederick, 2 bbl., 3,532-95 ft.

Upton County

Longview area: Phillips Properties 6 Matthews, dry at 3,727 ft.

EAST CENTRAL TEXAS COMPLETIONS

(24-hr. gages)

Anderson County

Long Lake field: Magnolia 2 Focke, 235,000,000 cu. ft. gas, 5,213-68 ft.

Morris County

Wildcat: C. B. Zuber 1 Blackburn, E. B. Smith Sur., top Austin chalk 3,940 ft., Georgetown lime 4,325 ft., Paluxy 5,504 ft., dry at 5,676 ft.

Navarro County

Misc. field: C. D. Bird 1 Birdwell, dry at 582 ft.
C. D. Bird 2 Birdwell, dry at 960 ft.
Curry field: B. L. Walkup 1 Eckhardt, dry at 3,010 ft.

Smith County

Chapel Hill field: Sun 1 Dickerson, 380 bbl., ¾-in. choke, 4,000 gal. acid, perf. casing 8,216-33 ft., T.D. 8,342 ft.
Sun 1 Freelander, 245 bbl., ¾-in. choke, 8,414-36 ft.

Wood County

Hawkins field: Demer & Stewart 1 Beavers, 119 bbl. in 6 hr., top sand 4,672 ft., T.D. 4,869 ft.
General American and George DeMontrand 1 Gray & DeMontrand, 117 bbl. in 6 hr., perf. casing 4,658-88 ft., T.D. 4,810 ft.
General American 1-A Holmes, 115 bbl. in 6 hr., no sand record, T.D. 4,814 ft.
Hollandsworth Drilling Co. 1 Green, 109 bbl. in 6 hr., perf. casing 4,646-4,700 ft. and 4,740-60 ft., T.D. 4,836 ft.
Holley & Caraway 1 Crow, 200 bbl. in 18 hr., perf. casing 4,784-90 ft., top sand 4,524 ft., T.D. 4,858 ft.
Humble 1 Shamburger, 174 bbl. in 18 hr., top sand 4,642 ft., T.D. 4,890 ft.
Humble 1 Lotis, 342 bbl. in 18 hr., perf. casing 4,569-75 ft., T.D. 4,712 ft.
Pierce & Smith 1 Morrison, 118 bbl. in 6 hr., perf. casing 4,620-25 ft., 4,645-50 ft., 4,710-20 ft., T.D. 4,833 ft.
O. F. Wencker 2 Surratt, 338 bbl. in 18 hr., top oil sand 4,672 ft., T.D. 4,880 ft.

EASTERN TEXAS WILDCAT REPORT

Anderson County

Griffith Bros. 1 Clayton, William Frost Sur., Elkhart area, coring 5,975 ft.
B. T. Royalties 1 Coleman, NW cor. Coleman tract in J. A. Box Sur. 10, top Pecan Gap 4,450 ft., Austin 4,987 ft., drilling 5,042 ft.

Camp County

Lucey 1 McKenzie, L. William Sur., ¾ mi. W of Pittsburg field, fishing 5,062 ft.

Cherokee County

Bobby Manziel 1 Nagel, T. Timmons Sur., 3½ mi. NW Mount Selman, derrick.

Falls County

Kelsey & Miller 1 Reed, A. de la Serda Sur., 3 mi. NE Marlin, top Georgetown lime 1,812 ft., S.D. 2,203 ft.

Freestone County

Carter-Gragg 1 Mims, J. M. Lyons Sur., 2½ mi. S Butler, 9-in. casing 990 ft., top Woodbine 5,197 ft., coring 5,205 ft.
Westbrook & Whistler 1 Coleman, H. Howard Sur., 2½ mi. SW Streetman, location.

Red River County

Albert Wooley 1 Nelson, J. Bowerman Sur., 3 mi. S Allen Mill, drilling 800 ft.

Rusk County

Ross Sears 1 Pool, George May Sur., Laneville area, show oil in Woodbine sand 4,052-60 ft., cemented casing, T.D. 4,128 ft., will perf. and test, S.D.O.

Van Zandt County

Hickok & Reynolds 1 Brown, Leander Smith Sur., 5 mi. SW Canton, 10¾-in. casing 260 ft., top Pecan Gap 2,370 ft., Austin 3,200 ft., drilling 3,585 ft.

Texas Gulf Coast

(Continued from Page 171)

Hardin County

Sour Lake field: H. B. Baker 2 Swayne, 191 bbl., ¼-in. choke, top sand 1,551 ft., T.D. 1,581 ft.

Jackson County

Ganado field: Texas 2 Hultiquist, 165 bbl., ⅛-in. choke, perf. casing 6,418-30 ft., T.D. 6,503 ft.
Lolita field: Luling Oil & Gas Co. 1 Rogers, 105 bbl., 7/64-in. choke, perf. casing 5,291-95 ft., T.D. 5,296 ft.
Skelly 5 Susie Ward, 28 bbl., 3 hr., 5/32-in. choke, perf. casing 5,271-76 ft., T.D. 6,413 ft.
Maubro field: Humble 1 Edwards, 146 bbl., 15 hr., ¼-in. choke, perf. casing 5,215-20 ft., T.D. 5,228 ft.
West Ranch field: Magnolia 145-A West, 53 bbl., ⅜-in. choke, perf. casing 5,584-5,600 ft., T.D. 5,767 ft.
Magnolia 147-A West, 62 bbl., 12 hr., 9/64-in. choke, perf. casing 5,560-70 ft., T.D. 5,581 ft.
Humble 7 State, 18 bbl., ¼-in. choke, sand 5,548-63 ft., T.D.
Magnolia 148-A West, 74 bbl., ⅜-in. choke, perf. casing 5,562-76 ft., T.D. 5,590 ft.
Magnolia 151-A West, 66 bbl., 8 hr., ¼-in. choke, perf. casing 5,548-60 ft., T.D. 5,570 ft.

Jefferson County

Lovells Lake field: Humble 20 Jefferson Land Co., 151 bbl., ⅛-in. choke, top sand 7,786 ft., T.D. 7,794 ft.

Liberty County

Esperson field: General Crude 24 Davis, 58 bbl., pumping, perf. casing 4,440-55 ft., T.D. 6,037 ft.

Matagorda County

Buttermilk Slough field: Rowan Drilling Co. 1 American Realty Co., dry, T.D. 7,830 ft.
North Markham field: Sun 1 Braman, 175 bbl., ⅛-in. choke, perf. casing 7,706-16 ft., T.D. 8,045 ft.

TEXAS GULF COAST DRILLING REPORT

Brazoria County

Glenn McCarthy 1 Marion, Bailey Prairie area, S. Carter Sur., drilling shale and lime 8,049 ft.
Pan American 2 Koontz, deep test southeast flank Damon Mound, H.T.&B. Sur., Sec. 14, drilling shale 7,359 ft.

Chambers County

Humble 20-A State, Red Fish Reef field, top Frio 8,590 ft., drilling shale 9,102 ft.
Humble 10-C 46 State, Fishers Reef field, top round Marginulina 7,111 ft., flat Marginulina 7,203 ft., drilling shale 8,503 ft.

Fort Bend County

Providence Oil Co. 1 Hatfield, Clodine area, H. D. Brown Sur., drilling shale 5,275 ft.

Jefferson County

Humble 1 William Baird, Sabine Pass area, W. P. H. McFaddin Sur. No. 5, drilling shale 6,045 ft.

Liberty County

Hebert & Smith et al 1 Willis, Sec. 7, H.T.&B. Sur., moving in material.

Wharton County

Lon H. Cron et al 1 McGill, Lissie area, A. Schwartz Sur., drilling shale 6,750 ft.

Indiana Fields

(Continued from Page 187)

Monroe County

Terry Deskins 1 Cowling.....SW SW NW 34-7n-1e S.D. 923 ft.

Perry County

B. A. Vonberg 1 Frazier.....W½ W½ NW 1-6s-3w S.D. 665 ft.
H. E. Pollock 1 J. F. Heck.....SE SE SE 16-7s-3w Show oil 765-73 ft., not commercial, drilling 920 ft.

Posey County

R. B. Creager et al 1 Wilborn..NW SE NE 1-7s-12w T.D. 1,728 ft., 30-qt. shot 1,713-28 ft., cleaning out and putting on pump.
Carter 1 Stallings.....NW NE SE 35-5s-14w Location, first report.
T. B. Dirickson et al 1 Utley..NW SW NE 26-6s-13w Barlow 2,397-2,403 ft., Cypress 2,430 ft., oil 2,430-50 ft., 7-in. 2,431 ft., T.D. 2,452 ft., rigging up standard tools.
Hollandsworth 1 Egli.....NE NE SW 19-6s-12w First report, rig.
Lelalu Oils et al 1 Dickhaut...SW SW NE 19-6s-12w Glen Dean 2,094 ft., Barlow 2,335-44 ft., Cypress 2,356-65 ft., saturated sand, T.D. 2,370 ft., will run casing.

Spencer County

Ladmer et al 1 Cokes.....N½ SE NE NE 12-7s-8w T.D. 1,047 ft., sand 1,044-47 ft., est. 30 bbl., will not shoot.
Texas 1 Scamahorn.....SW NE NW 20-7s-6w Kincaid 759 ft., Clore 843 ft., Palestine 898 ft., Menard 921 ft., oil 914-21 ft., flowed 1 bbl. an hr., T.D. 922 ft., will run tubing.

Troy Refining 1 Grass.....S½ SE NE SE 11-6s-4w Drilling 355 ft.
Louis Wade et al 1 Squire.....SE SW SW 7-7s-6w Sand 875 ft., show water, drilling 877 ft.
Hempner et al 1 Payton.....NW NW SE 32-7s-7w Rig.
Jesse Wilson et al 1 McCoy.....NE NE NE 12-7s-8w Drilling 200 ft.

Sullivan County

G. W. Boyce et al 1 Kelly....SW SW NE 10-8n-11w New Albany 2,526 ft., Devonian 2,618 ft., show oil 2,702-10 ft., water 2,741 ft., drilling 2,760 ft.
W. J. Reynolds 1 Hyde.....SW NE NE 9-8n-10w S.D. 1,621 ft.
Continental 1 H. Schroeder.....NW NW SE 34-6n-8w Rig, first report.

Vigo County

Wooters 1 Ellsworth.....SW NE NE 16-12n-10w New Albany 1,857 ft., S.D. for pipe 1,870 ft.

Vanderburg County

R. A. Mitchell et al 1 Keck.....NE SW SW 6-7s-11w S.D. 1,723 ft.
T. W. Drake 1 Nurrenbern.....SW NW NW 5-7s-11w T.D. 1,159 ft., will run 5-in.

EASTERN KENTUCKY

ASHLAND, Ky., May 19. — Two "St. Peter" tests share the eastern Kentucky spotlight this week with the completion of one good oil well and five gas wells. One deep test has passed the 5,000-ft. mark and continues to hold much attention.

Montgomery County enters the deep-test field with two operations under way. Operator Anderson has started a well on the Frazier farm on Slate Creek in eastern Montgomery County. Mr. Anderson is from Oklahoma City, Okla.

J. P. Perry is the operator on the other Montgomery deep test with the 1,000-ft. level reached in Trenton lime in the well on the Pete Greenwade tract on Slate Creek. This well is about 3 miles from the Frazier farm.

Price Fraley and Herman Tackett report the completion of their well on the McQuinn heirs land near Pilot, in Powell County. The well produced 50 bbl. of oil in 8 hours.

Cumberland Petroleum has reached 5,079 ft. in the deep test on the L. C. Bailey farm near Oil Springs in Magoffin County. The bailer and sand line has been fished out of hole and the machinery is being repaired with drilling scheduled to be resumed within the next few days.

Knott County: Kentucky-W. Va. 624 Joseph King, on Bates Branch, T.D. 1,775 ft., 1,884,000 cu. ft. of gas, R.P. 507 lb., 48 hr., Maxon sand.
Kentucky-W. Va. 528 Joseph Hall, T.D. 2,702 ft., in shale, 160,000 cu. ft. gas, R.P. 260 lb.
Floyd County: Kentucky-W. Va. 610 Elijah Akers, T.D.

MISSISSIPPI AND SOUTHEAST

Dry Holes and Low Tinsley Wells Slow Mississippi Play

By GEORGE WEBER

JACKSON, Miss., May 19.—The Tinsley field of Yazoo County, Mississippi, was further defined on the south last week. The failure of two outpost wells to encounter the Woodruff sand above the oil-water contact has halted the progressive extension of the field to the southeast, and may cause a swing of interest to the west of the currently active area. One of two interesting wildcats in the state was abandoned in Clarke County, and the second prospective discovery, in Sharkey County, has reported no improvements in oil show. More proposed wildcats are reported and new operations in Mississippi and Alabama were staked last week, sustaining the current wildcatting activity.

SUMMARY OF COMPLETIONS

Mississippi

	No.	Bbl.	Footage
Oil wells: Tinsley....	3	1,773	14,328
Dry holes: Tinsley..	2	.....	10,190
Wildcats	2	.....	4,712
Total	7	.....	29,230

Alabama

Dry holes: Wildcats	1	.....	305

Tinsley

Tinsley production declined last week for the first time since late March, but runs are not expected to show much decrease, with new outlets being offered for Tinsley crude. More Tinsley crude is being moved north with the addition of the Delta Refining Co. of Memphis, Tenn., to consumers, and it is reported that some crude may be moved to a St. Paul, Minn., refinery, pending completion of a current transaction.

Drilling activity in the southeastern extension area will continue fairly strong for a few weeks as inside locations are drilled, but the failure of two more wells, defining Woodruff production on the south may cause a falling off of activity shortly. W. B. Johnson Drilling Co. 1 Logan and Magnolia Petroleum Co. and Sylvan Producing Co. 1 M. Payne were abandoned after testing salt water in the Woodruff section. The two failures define the field on the south. Since the limits of production along the east side of the extension area are already fixed, exploration should now be expected to swing to the west of the area, which has seen some extension during the past several weeks.

Wildcats

Walsingham & Earles abandoned 1 School Land, located in 16-4n-15e, Clarke County, after testing salt water at 3,662-65 ft. The wildcat has a reported show at that level, but no oil was tested in the drill-stem test of the above section.

In Sharkey County, British American Oil Producing Co. is still swabbing 1-A Houston, 23-11-7w, which, after several days of bailing, showed an estimated 25 bbl. of live oil on the pits. The operators on a previous test recovered 30 ft. of mud and 60 ft. of oil-cut mud, comprising about 26 per cent oil, but after setting casing above the oil show at about 3,278 ft. only the above results from swabbing have been reported by the company. At latest reports bailing has brought the fluid level in the hole down to about 1,200 ft. from the top.

In Copiah County Ze Nae Oil Corp. has reentered 1 W. W. Broom, bottomed at 3,628 ft., and plans to deepen it. In addition, new wildcats are being planned in Attala, Clarke, Stone and Jasper or Jones counties.

A rank wildcat in the northeastern part of the state, Iowa Oil Corp. 1 J. W. Tucker estate, NE NE 20-5s-4w, had cellar and pits dug last week and was due to start drilling by June 1. The operator is a new company formed for the purpose of financing the well. The company will drill with cable tools.

Alabama activity has revived to some extent, with the staking of the W. W. Newman 3 Nichols, a shallow wildcat in Madison County, and resumption of drilling is planned in other shallow tests in the northwestern part of the state. Union Producing Co. 1 Waite, deep Clarke County wildcat, is moving in material.

MISSISSIPPI COMPLETIONS

Wildcat—Clarke County

Walsingham & Earles 1 School Land, SW NW NE 16-4n-15e, dry, T.D. 4,057 ft.

Wildcat—Marshall County

C. B. Blosser 1 C. Stansback, SE SE 19-3s-4w, dry, T.D. 655 ft.

Tinsley—Yazoo County

Hassie Hunt 2 McMurtray, NE SE 26-10-3, 672 bbl., ¼-in. choke, T.P. 60 lb., C.P. 0 lb., T.D. 4,840 ft., 7-in. casing 4,798 ft., Woodruff sand 4,677-91 ft.
W. B. Johnson Drlg. Co. 1 Logan, NE NE 1-9n-3w, dry, T.D. 5,077 ft., Woodruff sand 4,995-5,067 ft., salt water.
Magnolia and Sylvan 1 M. Payne, SW SE 36-10-3, dry, T.D. 5,113 ft., Woodruff zone 5,066-5,113 ft., salt water.
Union 2 R. A. Carson, NE NE 26-10-3, 816 bbl., 32/64-in. choke, T.P. 20 lb., T.D. 4,678 ft., 7-in. casing 4,674 ft., perf. 4,618-40 ft., Woodruff zone 4,617-34 ft.
Union 19 Stevens, NE SW 12-10-2w, pumped 95 bbl. oil, 5 bbl. b.s. and w. in 8 hr., T.D. 4,810 ft., 7-in. casing 4,755 ft., Woodruff zone 4,757-68 ft., crossed fault 4,768 ft. into Eutaw.

ALABAMA COMPLETIONS

Wildcat—Madison County

W. W. Newman 4 Nichols, NE NE NE 2-6s-2e, dry, T.D. 305 ft., shows of gas 275-80 ft. and 285-90 ft., hole full sulfur water.

MISSISSIPPI DRILLING REPORT

Chickasaw County

Century 1-A Flaherty, S½ SW SW 8-13s-3e, drilling by fish 2,000 ft.

Wildcat—Copiah County

Ze Nae Oil Corp. 1 W. W. Broom, SW SW SW 1-9n-8e, old well drilled deeper, old T.D. 3,628 ft., cleaning out 2,250 ft.

Grenada County

H. T. Salter et al 1 Carpenter, 6-12n-7e, moving in rig.
Grenada County Drlg. & Dev. Co. 1 Conn. General, NW SE 28-23n-5e, T.D. 3,210 ft., S.D. repairs.

Leake County

Sinclair 1 Pearl River, NW SE NW 28-9n-6e, rigging up.

Marshall County

P. J. Lunati 1 fee, SW SE 31-3s-1w, S.D. 1,130 ft.

Montgomery County

Henderson 1 School Land, SE NE NW 16-19n-6e, drilling 1,825 ft., report slight show gas 1,030 ft.

Noxubee County

Hope & Thompson 1 Donahoo, C NW 25-16n-17e, S.D. 3,000 ft.

Sharkey County

British American 1-A Houston Est., NW NE SW 23-11-7w, T.D. 3,303 ft., set 7⅝-in. casing 3,278 ft., bailing salt water and some live oil, fluid column 1,200 ft. from top of hole.

Warren County

Waggoner Bros. 1 Parker, NW NW 17-14n-1e, T.D. 7,013 ft., preparing to deepen, cleaning out 3,500 ft.

Yazoo County

Sinclair 1 C. C. Swayze, W½ E½ W½ 23-12n-1e, drilling 4,475 ft.

ALABAMA DRILLING REPORT

Clarke County

Union Producing 1 M. M. Waite, C NW 27-8n-1w, moving in rig.

Fayette County

B. L. Fillingame 1 Ala. Education Ass'n., NW SW 3-16s-12w, T.D. 1,700 ft., S.D. for wire line.

Franklin County

E. O. Heath, Jr., 1 W. O. Hester, SW SW 4-6s-12w, T.D. 600 ft., moving in pipe.

Limestone County

Shaw, Johnson & Thompson 1 E. E. Carter, SE SW 35-2s-5w, S.D. 520 ft. in lime.

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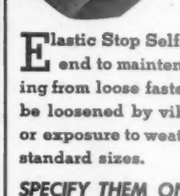

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2,675 ft., 133,000 cu. ft. gas in Big lime, and 60,000 cu. ft. in shale.
Kentucky-W. Va. 5290 Martha Alley, on Frazer Creek, T.D. 3,261 ft. in shale, 189,000 cu. ft. gas.
Pike County: Kentucky-W. Va. 5294 Tandy Howell, 103,000 cu. ft. gas, T.D. 3,555 ft. in shale, R.P. 448 lb.
Kentucky-W. Va. 5290 Martha Allen on Frazier Creek, T.D. 3,261 ft. in shale, 189.000 cu. ft. gas.

A spurt of drilling activity has been reported in Menifee County but details have not been available.

WESTERN KENTUCKY

OWENSBORO, Ky., May 19.—A new producer was obtained in the Hebbardsville pool of Henderson County during the week end when W. E. Hupp 3 King-Pruitt made an estimated initial of 60 bbl. a day. Production is from the Tar Springs sand. The hole, now bottomed at 1,565 ft., filled with oil to a depth of 300 ft. as 10 ft. of pay were being drilled from 1,555-65 ft. Last week a ¼-mile northwest extension to the Hebbardsville pool, Sohio Corp. 1 I. M. Mauzy, which initialed 45 bbl. in 19 hours, was completed in the Tar Springs.

Meanwhile, in Grayson County, Sun Oil Co. 2 George Wood, a wildcat about 8 miles east of Litchfield, was drilling near the top of the Ordovician at about 1,300 ft.

Henderson County

Hebbardsville district: Sohio 1 L. M. Mauzy, testing second Jett 1,501-08½ ft., 45 bbl. in 19 hr., Tar Springs.

McLean County

Northwest Livermore district: S. Malis 2 Dan Hall, 500,000 cu. ft. gas Bethel sand 1,555-59 ft., and water 1,559-63 ft., abandoned.

Ohio County

Sunnydale district: George Williams 5 J. H. Dodson, 10 bbl., 80-qt. shot, Jett sand 466-72 ft., T.D. 527 ft. George Williams 4 George Russell, rigging up.

Oklahoma Fields

(Continued from Page 175)

St. Louis, Pottawatomie County: Commercial 3 Bray-McCully, SW SE SE 6-7-4, flowed 500 bbl., Hunton 3,917 ft., 7-in. 3,918 ft., T.D. 3,952 ft., acid.
Kerlyn 2 Ogee, NE SE SE 8-7-5, dry, T.D. 3,402 ft., pumped 1 bbl. oil and 5 bbl. water in 25 min., 5-in. 3,364 ft., sand 3,364 ft.
Kerlyn 1 Cherry-A, NE SE NW 32-8-5, pumped 189 bbl., Wilcox 4,319 ft., 6-in. 4,320 ft., T.D. 4,329 ft.

WILDCATS DRILLING

East of the Meridian

27-2-9, W½ SE NW .....Ramsey 1 Harryman T.D. 5,002 ft., 5½-in. 4,988 ft., loaded hole with 2,000 ft. water, perf. 4,917-35 ft., est. 3,000,000 cu. ft. gas blew water for 5 hr., perf. again, slight increase, perf. 4,908-25 ft., no increase, perf. 4,899-4,917 ft., tried to unload but not enough gas, perf. 4,848-80 ft., well cleaned itself, blew 724,000 cu. ft. wet gas for 1½ hr. and sprayed some distillate, killed well with water and perf. 4,790-4,820 ft., 4,830-80 ft., 4,881-85 ft. and 4,830½-62½ ft., no increase, flows and sprays water every 10 minutes, cleaning itself, coal County.
15-4-6, SW NW .....Josephson 1 McCurry Shot 851-61 ft., flowed 12 bbl. in 12 hr., S.D., Pontotoc County.
14-5-6, SE SE SE .....Norville 1 Fleet T.D. 2,285 ft., P.B. 2,067 ft., perf. 1,999 ft., est. 1,000,000 cu. ft. gas, perf. 1,540-48 ft., 1,562 ft., 1,505 ft., 1,512 ft., 1,514 ft., 1,467 ft., 1477 ft., 1,535 ft., 1,537½ ft., 1,289 ft., 1,080 ft., no increase in water or oil or gas, perf. 895 ft., hole full muddy water, S.D., Pontotoc County.
16-7-5, NW NW NE .....Helmerich & Payne 1 School First report, Pottawatomie County.
31-7-7, SW NE NE .....Eagle 1 Mann T.D. 2,208 ft., electrical log showed sand 2,008-45 ft., 7-in. 2,008 ft., P.B. 2,060 ft., shotw est. 1,000,000 cu. ft. gas, Seminole County.
16-9-4, E½ NE SW .....Crosbie 1 School Land Wilcox 4,714-22 ft., D.S. test 4,704-22 ft., salt water, P.B. Viola, perf. 4,580-4,620 ft., Viola 4,582 ft., acid, swabbed 10 bailers, flowed, testing, Pottawatomie County.
11-9-9, SE SW SW .....Mid-Continent 1 Felix Bartlesville 2,180-2,300 ft., sand 2,405-20 ft., some show oil, Booch 2,622 ft., drilling 3,070 ft., Hughes County.
13-9-9, SW SW NW .....Cromwell 1 Turner Lucas Gilcrease 2,857 ft., Cromwell 3,325 ft., cored spotted stained sand streaks 3,327-38 ft., 3,338-48 ft., and 3,349-61 ft., Hughes County.
23-9-11, SW NW SE .....Arrow 1 Grannerman T.D. 3,445 ft., standard tools, deepened to 3,446 ft., bailed salt water with show gas, H.F.W., to swab, Hughes County.
27-9-24, NW SW NW .....Western Oklahoma 1 Ward Drilling 3,955 ft., Le Flore County.
33-10-8, NE SW SE .....Mico 1 Kidd First report, Seminole County.
22-10-11, E½ NE NE .....Smith 1 Johnston Booch 2,051-72 ft., show oil and gas, sand 2,348 ft., drilling 2,358 ft., Okfuskee County.
4-10-12, NE NE SE .....Carter 1 Bucco Drilling 2,601 ft., Okfuskee County.
22-11-8, SW SW NE .....Shell 1 Keyes-B Surface casing, Okfuskee County.
2-11-10, NE NE NW .....Sunray 1 Brooks Hunton 3,678 ft., cored 3,665-98 ft. and 3,698-3,728 ft., Sylvan 3,751 ft., Wilcox 3,882 ft., cored 3,884-96 ft., drilling 3,918 ft., Okfuskee County.
15-12-9, NW SE NW .....Texas 1 Butcher T.D. 4,046 ft., P.B. 3,323 ft., 7-in. 3,292 ft., shot 3,310-23 ft., swabbed 60 bbl. in 24 hr., flowed 57 bbl., 41-gravity, Okfuskee County.
24-13-17, SE NE NW .....Pine 1 Lacey Lime 1,286 ft., drilling 1,328 ft., Muskogee County.
20-14-9, SW SE SW ..... Burke-Greis 1 Peabody Wilcox 4,015 ft., T.D. 4,028 ft., P.B. 2,251 ft., no show, 7-in. 2,153 ft., S.D., Creek County.
20-18-1, SE SE NW ....Anderson-Prichard 1 McGuire Drilling 1,120 ft., Payne County.
25-20-6, SW SW SW ..... Sand Springs 1 Launer Drilling 1,132 ft., Pawnee County.
16-22-1, SE SW SE ..... Superior 1 Faubean Drilling 3,152 ft., Noble County.
29-25-7, NE NE SW ..... Black Jack 1 Osage Drilling 1,115 ft., Osage County.

West of the Meridian

12-2-5w, SE NW NW ..... McCasland 1 Prine T.D. 2,395 ft., no show, S.D., Stephens County.
33-2-5w, SE NE SW ..... Helmerich & Payne 1 Cryer Drilling 4,295 ft., Stephens County.
33-6-10w, NE NW ..... Stephens 1 Pohlemann Rip casing 3,362-70 ft., show oil, P.B. 3,375 ft., T.D. 3,534 ft., Caddo County.
13-7-2w, SE NW NE ..... Delaney 1 Montgomery Dense 7,540 ft., dolomite 7,620 ft., Wilcox 7,640 ft., cored dolomitic sand and sand 7,640-50 ft., show oil, run 7-in., Cleveland County.
17-15-3w, SW SE SW ..... Continental 1 Lenigar Avant 4,430 ft., Hogshooter 5,048 ft., fishing 5,103 ft., Logan County.
22-15-3w, SE NE SE .... G. & M. Drilling 1 Basserman Big lime 5,580 ft., Oswego 5,625 ft., base Pennsylvanian 5,895 ft., Hunton 5,998 ft., drilling 6,015 ft., Logan County.
18-17-1w, NE NW SE ..... Big Chief 1 Hirzel First Wilcox 5,443 ft., drilling 5,468 ft., Logan County.
13-17-2w, NE NE SE ..... Big Chief 1 Trim Drilling 2,730 ft., Logan County.
29-21-1w, SE SE SW ..... Samedan 1 Briggs Drilling 3,140 ft., Noble County.

South of the Base Line

18-3s-10e, SW NE NE ..... Matson 2 Rowland Show oil and gas 320 ft., drilling 360 ft., Atoka County.
11-7s-7w, S½ NW NW ..... Gulf 1 Nesmith Cellar and pits, 6,000-ft. or Arbuckle test, Jefferson County.

Nebraska-Missouri

((Continued from Page 178)

Missouri had one more dry hole the past week. Except for some shallow gas tests, the northwest sector of Missouri was completely quiet.

MISSOURI COMPLETIONS

Thorsen & Pebley 1 Grant ..... SE SE 23-62n-40w Dry, Hunton 2,309 ft., Holt County.

MISSOURI DRILLING REPORT

Campbell 1 Rust ..... N½ NW SW 21-53n-26w Moving in, Ray County.
Jackson & Rust 1 Hayes ..... NE NE 22-66n-42w Old well drilled deeper from 2,192 ft., Hunton 2,092 ft., cored 2,158-72 ft., no show, slight stain 2,515-25 ft., Sylvan shale 2,750 ft., Viola 2,797 ft., drilling 2,840 ft., Atchison County.

NEBRASKA DRILLING REPORT

Uhri 1-A Ogle .....NW SE SE 9-1n-14e T.D. 2,264 ft., 180 ft. fluid in hole, mostly oil, Richardson County.
Palensky 2 Kalous .....SW SW SW 5-2n-13e 10-in. 97 ft., Richardson County.
Rider 1 Warren ..... NE NE 21-3n-5e No Mississippi lime, lower Viola 2,580 ft., Decorah 2,702 ft., Wilcox 2,770 ft., stain 2,773-77 ft., cored sand 2,777-80 ft., no show, Gage County.
Miller 1 Bethoud ..... E½ NW SW 2-4n-6e Some show oil 608 ft., drilling 753 ft., Gage County.
Keas 1 Kiechel .....SE SE SE 4-5n-13e S.D. 125 ft., Nemaha County.
Bow & Arrow 1 Wrightsman ..W½ SW NW 36-6n-14e Underreaming 8-in. 1,515 ft., Nemaha County.
Ellis 1 Armstrong .....W½ NE 10-6n-15e Drilling 355 ft., Nemaha County.
Zimmer 1 Roddy .....S½ SE SW 31-9n-14e S.D. 2,500 ft., Cass County.
O. O. Petroleum 1 Jensen....NW NW NW 26-14n-37w S.D. 600 ft., Keith County.
Ohio 3 Bahr ..... SE SW 7-1n-16e Coring Hunton lime, Richardson County.
Ohio and Harper 1 Sibbernsen ..... CNL NW NE NW 20-1n-16e Hunton 2,204 ft., testing Viola lime, Richardson County.
Black Gold 1 Watkins A ..... SE SE 30-3n-16e Hunton 2,489 ft., Richardson County.
Black Gold 1 Watkins B ..... NE NW 31-3n-16e Drilling 1,000 ft., Richardson County.
Black Gold 1 Schaible ..... SE NE 31-3n-16e Hunton 2,515 ft., T.D. 2,521 ft., filled 300 ft. with oil, Richardson County.

Bradford, Pa., Producers Hold Tenth Meeting

BRADFORD, Pa., May 19.—John Calhoun, research assistant in water-flood studies at the Penn State School of Mineral Industries research department, will be located in Bradford, Pa., this summer as a resident technician, it was announced at the annual meeting of the Bradford District Pennsylvania Oil Producers Association.

The meeting, the tenth annual gathering, brought comment on high points of the work of the association in the 10-year period, from six past presidents: L. H. Smith, D. T. Andrus, Cornell N. Pfohl, Jr., C. E. Streeter, A. E. Booth, and D. B. Tanner. R. S. Pringle, president of the association, presided and J. C. Martin, executive secretary, and G. G. Bauer, member of the association staff, also spoke.

John W. Bryner and David Scott, Jr., were the new members elected to the 34-member board of directors.

Hugh Grant was named president, A. C. Simmons and J. P. Jones vice presidents and G. H. Daggett secretary-treasurer. Mr. Grant, who succeeds R. S. Pringle, Jr., served as first vice president last year.

Odessa Will Stage Second Annual Little Oil Show

The second annual Little International Oil Show will be held in Odessa, Tex., Saturday and Sunday, June 21-22.

The home of the Little International Oil Show is a 40-acre, $200,000 plant located in the outskirts of Odessa, the city being the geographical, production, operating, and service of supply center of the great Permian basin, with 14,500 producing oil wells at this time.

M. L. (Dick) Atkinson, West Texas production superintendent for Phillips Petroleum Co., is serving as general chairman.

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Personal Paragraphs

H. R. AUERSWALD, assistant general superintendent of Gulf Oil Corp., has been elected president of the Engineers Club of Tulsa.

IVAN G. BURRELL, formerly district foreman for Ohio Oil Co. in the Rodessa field in East Texas, and more recently superintendent of production at Owensboro, Ky., has been transferred to Marshall, Ill., where he has assumed charge of the newly organized petroleum engineering department in the Illinois field. Associated with Mr. Burrell are M. H. FLOOD and D. C. ALBERS.

J. B. HALSTEAD has been made superintendent of Sun Oil Co.'s new office at Waycross, Ga.

FRANK PHILLIPS, chairman of Phillips Petroleum Co., Bartlesville, Okla., is in Mineral Wells, Tex., where he will spend a month resting.

DOUGLAS LANIER, chief of the leasing department, Gulf Oil Corp., Houston, Tex., was called to Beaumont last week by the death of his mother.

S. H. BROWN, head of the office pay-roll department, Arkansas Fuel Oil Co., Shreveport, La., has been elected president of the Shreveport Junior Chamber of Commerce.

W. R. DAVIS, who started work for the Southern California Gas Co. in 1926 as a chart collector, has been promoted personnel manager, succeeding GUY W. WADSWORTH, JR., who was recently elected vice president.

New officers of the Panhandle Geological Society, recently elected at a called meeting in Amarillo, Tex., are: President, E. H. POWERS, Gulf Oil Co.; vice president, EARL ARMSTRONG, Shamrock Oil & Gas Corp., and H. H. HINSON, Bureau of Mines, reelected. FRANK BLANCHARD, of Skelly Oil Co., served as president of the organization during the past year.

WILLIAM C. IMBT, Wichita, is now Kansas district geologist for Stanolind Oil & Gas Co., succeeding C. T. JONES, who is on leave of absence for a period of active service in the Army. Mr. Imbt was transferred to Wichita in August 1939 after serving in the Stanolind's geological departments at Midland, Tex., and Mattoon, Ill.

L. E. MURRAY, F. A. ROBINSON and ROBERT M. TRUPIN, Midland, Tex., have been granted charter for a new oil company to be located at Midland. It is the Seal Oil Co., to operate both as a producing and royalty company.

PAUL R. BEALL has rejoined Phillips Petroleum Co., Bartlesville, Okla., after an absence of several years. He is in the production department. Mr. Beall, a graduate of Purdue University, joined Phillips in 1927, and during his tenure was district engineer of the Arkansas division.

EDWARD DOUGHERTY, of the Bartlesville, Okla., research staff of Phillips Petroleum Co., has been transferred to Akron, Ohio.

CHARLES O. ROSSER, formerly in charge of the accounting division of the George Pace oil interests of Duncan, Okla., and later an independent operator at Wichita Falls, Tex., has moved to Tulsa and will practice as a petroleum accountant.

L. F. VAN HOUTEN, editor of the United Gas Log, house magazine of the United Gas Pipe Line Co. and affiliated companies, Shreveport, La., was in New York City last week to receive the third award for the internal division in the recent competition sponsored by House Magazine Institute. This was the highest award in its division for any oil or gas-company organ.

New assignments in Pure Oil Co.'s production engineering department include transfers of the following production engineers: KENNETH A. COVELL, from Fort Worth, Tex., to Tulsa producing; LAURENCE A. OGDEN, from Tulsa to Illinois producing; BART DE LAAT, from Illinois producing to Chicago office; and CHARLES F. TERRELL, JR., from Chicago office to Illinois producing at Olney.

Do You Remember?

From The Oil and Gas Journal Files

25 YEARS AGO

Mrs. Laura Drake, about 80, died at her home in Philadelphia, Pa., on May 18. She was the widow of Col. E. L. Drake, whose place in the history of the world is that of the founder of the petroleum industry.

T. A. O'Donnell has been elected president of the California Petroleum Corp. and all of its subsidiaries, succeeding E. L. Doheny, who has retired to give his entire attention to the Pan American and Mexican Petroleum affairs.

Secretary Daniels has appealed to President Wilson to take some action that would result in protecting the government oil reserves in California, as a part of the administration's preparedness plans.

Oklahoma City would like to be an oil town.

20 YEARS AGO

From The Hague last week the Dutch Government's reply to the American note concerning the Djambi oil fields in Sumatra was dispatched to Washington. Americans have given full freedom to foreign concerns to participate in oil operations in the United States, and on these grounds they are justified in demanding like privileges.

Long-distance telephone reports from A. E. Humphreys, Sr., at Mexia, Tex., to John B. Means, manager of the Tulsa offices of the Humphreys Petroleum Co., say that the Henry well, which blew in May 7, is gradually increasing its flows and is now flowing approximately 5,000 bbl. of oil daily.

10 YEARS AGO

Dr. Gordon N. Scott, technical adviser for the A.P.I. research committee, will proceed to the Gulf Coast to make inspection of pipe lines coated with various protective materials and buried in the Spindletop area. J. M. Johnson, Pure Oil Co., will assist, and Frank W. Yeager, of the Barrett Co., will make a complete survey of the test line.

The California State Legislature has passed the Sharkey compulsory proration bill.

GEORGE B. JOURNEAY has been appointed manager of the new Gulfshore Oil Co., at Houston, Tex.

TOM KELLERHUR, title man for Tide Water Associated Oil Co., has been transferred from Lafayette, La., to Monticello, Miss.

L. C. and A. L. INMAN, of Grayville, Ill., have organized the Inman Construction Co. and will engage in pipe-line construction work in the southern Illinois district.

J. W. COLLINS, Phillips Petroleum Co. scout in the Forest City basin with headquarters in St. Joseph, Mo., has been transferred to Bismarck, N. D.

JAMES B. HARRIS, safety director for Arkansas Natural Gas Co., Shreveport, La., has been appointed safety director of the Shreveport Chamber of Commerce. His committee includes C. L. HIGHTOWER, United Gas Pipe Line Co., education, and H. J. HANLON, Standard Oil Co. of Louisiana, engineering.

R. A. SPERRY, vice president of General Petroleum Corp., recently completed 20 years uninterrupted service with the company. Mr. Sperry joined General Petroleum Corp. in 1912 but was in the employ of other operators in the San Joaquin Valley from 1918 to 1921 and his present record reads from 1921.

COL. OSCAR NELSON, president of the United Carbon Co., Charleston, W. Va., visited the company's operations in the Texas Panhandle field last week. While in the Texas Panhandle the colonel purchased several fine Hereford cows from the McDonald herd at Hereford, Tex., for his pure-bred Hereford farm at Lewisburg, W. Va.

W. S. HERRON has been elected president of Okalta Oils, Ltd., Calgary, Alta., with H. F. HERRON vice president and F. WHITAKER secretary-treasurer.

R. N. POSTGATE, engineer in the production department for Shell Oil Co., Inc., Houston, Tex., has returned to his desk after spending the last month at the company's offices in California.

D. W. McDONALD, drilling superintendent in the West Lake Verret district for the Shell Oil Co., Inc., has been transferred to the St. Gabriel district in Iberville Parish, Louisiana.

F. R. SCHMIEDER, production manager for the Shell Oil Co., Inc., in the Ventura field, California, was a recent visitor to the company's South Texas division offices at Houston, Tex.

LT. P. R. DAVIS, engineer in the gas-pipe-line department of Arkansas Louisiana Gas Co., Shreveport, La., has left for Camp Davis, North Carolina, having been called to active duty in the coast artillery arm of the U. S. Army.

WILLIAM C. FITZHUGH, legal department, Arkansas Fuel Oil Co., Shreveport, La., is the first accredited judge recognized by the American Iris Society in the State of Louisiana. His hobby of gardening and specializing in native Louisiana iris has won him nation-wide fame.

P. B. WATSON, vice president and general manager of the W. R. Davis Inc., Houston, Tex., has been made president of the Valley Pipe Line Co., which was acquired by the company the past week. AUSTIN B. TAYLOR was made vice president and secretary, M. V. HANSELL was made vice president and JOHN H. BURNS treasurer.

Named Superintendent

Thomas Carlton Shaw, who on May 1, 1940, became superintendent of the Coronado Corp., Woodsboro, Tex., was born in Hamburg, Okla. He received his elementary schooling at Canadian, Tex., and was graduated from Kemper Military School in 1922. Later he completed a course in civil engineering at Kansas State College, Manhattan, Kans. His first job after graduation was with the Kansas City stock yards.

THOMAS CARLTON SHAW

His first job in the oil business was in the gasoline department of Phillips Petroleum Co., which company he left to join Magnolia Petroleum Co., in West Texas, in the construction department. Later, he transferred to the operating department to take charge of a gasoline plant in the Texas Panhandle.

In 1937 he left Magnolia and accepted the position as chief construction engineer for Panhandle Power & Light Co. in the construction of a large electric plant. On the completion of this plant he went to the Gulf Coast to become chief engineer for the Henderson Co. in the construction of the first high-pressure absorption plant at Agua Dulce.

Upon the entry of the Coronado Corp. into the distillate-recycling industry, Mr. Shaw joined the company as superintendent. He is married and has one child. For hobbies, Mr. Shaw claims fishing and tying flies.

Mr. Shaw was one of the originators of the Petroleum Industry Club of Alice, Tex. This club was organized for further study of the different phases of the industry. It meets once a month to dine and discuss problems of interest to members.

C. L. TISSUE, Houston, Tex., has formed the C. L. Tissue Drilling Co., with headquarters in the National Standard Building, Houston.

JOHN W. SUTTON, in the production department for Shell Oil Co., Inc., in the Houma district, has been transferred to the Iowa district as district superintendent.

W. N. FINNEGAN, JR., formerly assistant to the president of Humble Oil & Refining Co., Houston, Tex., has opened offices in the new Mellie Esperson Building where he will operate as an independent.

J. D. ROBINSON, Union Oil Co., has been appointed superintendent of production of the coast division and will be in charge of production of oil, gas and natural gasoline. He will make his headquarters at Orcutt in Santa Barbara County, California.

JOHN EIDOM, Hancock Oil Co., was elected president of the Los Angeles Bilge Club at the annual election held last week. J. J. SHREWSBURY, Hancock Oil Co., was elected treasurer, and T. W. PETERS, Standard Oil Co., was elected a member of the board of directors.

WILLIAM C. McDUFFIE, former receiver for Richfield Oil Corp. and previously in charge of production activities of Shell Oil Co., Inc., and at present president of Wilmington Gasoline Co., has been elected a member of the board of directors of Vultee Aircraft, Inc.

JOHN KANE, vice president, Foster Petroleum Corp., Bartlesville, and FRANK BUTTRAM, of Oklahoma City, president of the Independent Petroleum Association of America, have been appointed by Governor Phillips to serve on a nine-member commission which will administer Oklahoma colleges and universities.

E. R. OWEN, of the geological department of Phillips Petroleum Co.'s district office in Amarillo, Tex., will be transferred soon to the company's offices at Shawnee, Okla. DICK PUNCHES, in the Wichita Falls, Tex., office of the company, will replace Mr. Owen.

M. L. CASHION, Gulf Refining Co., Houston, Tex., has been named chairman of a group representing oil companies operating in coastal Louisiana. The group will confer with officials of the Department of Minerals on proposed regulations governing oil fields in the state, not covered by special orders.

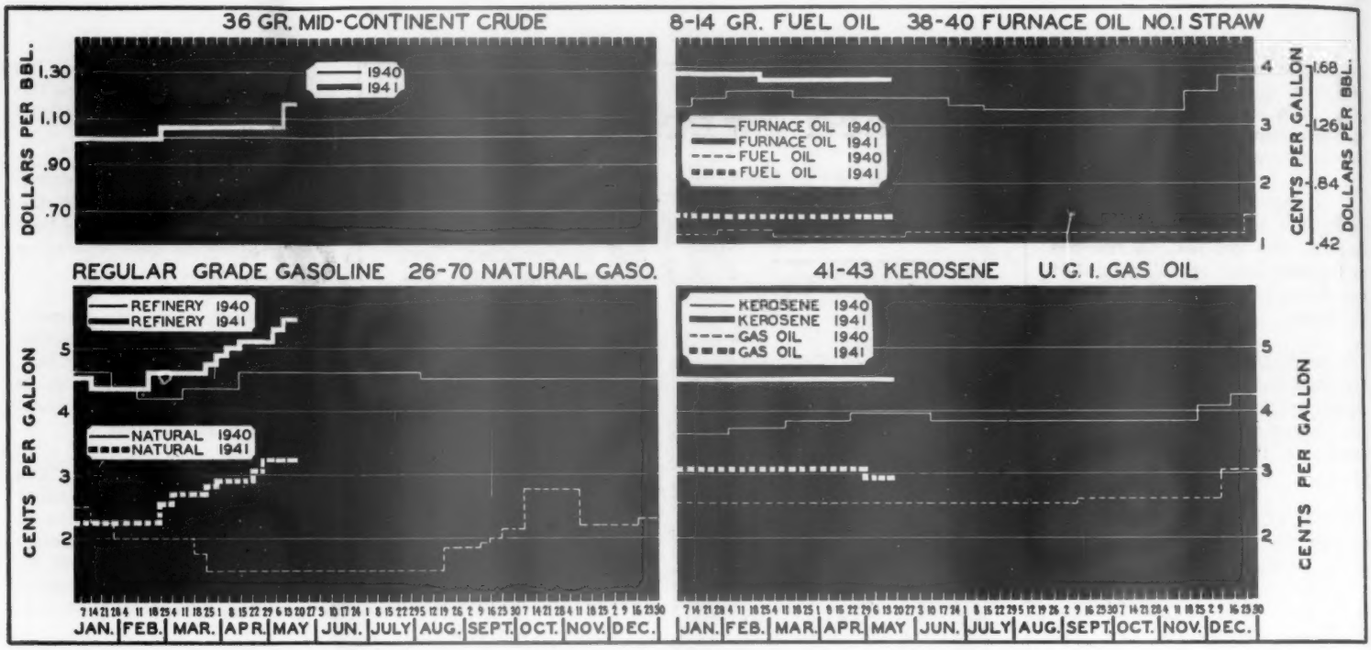
YERZY MORGENSTERN, owner and director of Morgenstern Oil Co. of Poland, the largest independent producer in that country before it fell to Germany and the U.S.S.R., is scheduled to arrive in the United States late this month. Mr. Morgenstern has a brother in this country, DAVID E. MORGENSTERN, a petroleum engineer now located in Evansville, Ind. Before departing for this country via Hungary, Rumania, Greece, Turkey, Egypt, Iraq, Iran, the Netherlands East Indies, and the Philippine Islands, Mr. Morgenstern lived a year in Soviet-occupied Poland. Mr. Morgenstern, who is coming to this country to make his permanent home, has visited in the United States in previous years when he was active in Polish operations.

GARLAND C. RICHARDSON, Indian Territory Illuminating Oil Co., Bartlesville, Okla., was elected chairman of the southwestern section, Society of Automotive Engineers, at the annual dinner of that organization in Tulsa last week. H. G. BENNETT, Mid-Continent Petroleum Corp., was named vice chairman, and W. F. LOWE, Natural Gasoline Association, secretary.

Shell Oil Co., Inc., is rearranging territories of its petroleum engineers for the Mid-Continent area. WILLIAM COPELAND remains chief production engineer at Tulsa. WILLIAM BURKE, formerly area engineer, goes to Wichita Falls to succeed TOM C. HOWER, transferred to Wichita, Kans., relieving C. H. KEPLINGER, coming to Tulsa. SAM LAMBERT will go from the Oklahoma division to the area office.

STANLEY H. CATHCART, former senior geologist in the Pennsylvania Topographic and Geologic Survey, has been reappointed to the staff of the survey. Mr. Cathcart resigned his post on the survey in 1937, to join Socony-Vacuum Oil Co. and was assigned to South America. He previously served for 7 years on the state survey.

Shifts: J. F. DARBY, president, Darby Lynde Co., from Chandler, Ariz., to Muskogee, Okla.; R. P. INGRAM, superintendent, Hanlon-Buchanan, Inc., from Baytown, Tex., to Texas City, Tex.; H. E. GRANBERRY, engineer, Magnolia Petroleum Co., from Texarkana, Tex., to Tucson, Ariz.; JAMES J. HOOPER, superintendent, Iberia Petroleum Corp., from New Iberia, La., to Broussard, La.; FRED B. GRAHAM, superintendent, Carter Oil Co., from Dix, Ill., to Eldorado, Ill.; DAN H. SHOLTUS, engineer, J. H. Tatlock, from Kechi, Kans., to Ellinwood, Kans.; H. BOYD MORRIS, engineer, Home Oil & Refining Co., from Great Falls, Mont., to Scott City, Kans.; J. A. ORD, geologist, Carter Oil Co., from Ardmore, Okla., to Kenmore, N. D.; DON PRESCOTT, engineer, Shell Oil Co., Inc., from Tulsa to Great Bend, Kans.



Representative Mid-Continent Quotations on Crude Oil and Refined Products, Basis Oklahoma (Group 3)

Mid-Continent Gasoline Prices Given Sixth Advance Since March

By H. STANLEY NORMAN

ANOTHER advance of ⅛ cent per gallon in tank-car motor-fuel prices, raises ranging from 0.5 to 1 cent per gallon on lubricating oils and another boost of 10 cents per barrel on Mid-Continent crude this week placed markets in the Group 3 area in the strongest position they have enjoyed for years. The crude-oil price advance of 10 cents per barrel was launched May 19 following 7 weeks behind a similar advance made on April 1.

All grades of fuel oil particularly kerosene and tractor fuels, remain strong. Distillate heating oils and residual fuels are strong and may move higher in sympathy with higher costs of raw material.

The latest advance in motor fuel prices is the sixth raise of ⅛ cent per gallon by Mid-Continent tank-car suppliers since the middle of March. The current tank-car quotation on regular gasoline at 5¼ to 5½ cents is 1 cent per gallon higher in the Mid-Continent than it was at the start of this year. Three-quarters of a cent have been added to the tank-car price since the middle of March.

Stock Liquidation Continues

Statistics for the first quarter of this year released last week by the Bureau of Mines show the domestic demand for motor fuel to have been more than 11 per cent greater than for the first 3 months of 1940. The rate of increase in domestic consumption of motor fuel for the 3 months is slightly less than reported for January and February but is still running more than 3 per cent higher than liberal estimates made at the start of the year. The 11 per cent rate of increase in demand for motor fuel is fairly evenly distributed throughout the country, although the middle western and eastern states have experienced higher than average demand because of concentration of defense activities in those areas.

Mid-Continent refiners are shipping record-breaking volumes of motor fuel into the middle western states of Missouri, Indiana, Illinois, Iowa, Nebraska, Michigan, Minnesota, and Wisconsin as well as other territories drawing supplies from Group 3.

Third-grade motor fuel is one of the most avidly solicited products on the list. Much of this fuel is moving to rural sections where consumption for agricultural purposes is setting new records. Buyers are soliciting potential sources of supply for material either in excess of previously placed contracts or for open-market purchase without success. No suppliers are willing to quote at a fixed price for delivery more than 10 days in advance of sales. Refiners are certain that prices will move higher when summer consumption reaches its peak during the next 3 months and the crude advance May 19 added emphasis to this conclusion. Refiners point out that current stocks of automotive-engine gasoline are less than 88,000,000 bbl., compared to approximately 98,000,000 bbl. at this time last year when an advance of 6 per cent in demand was considered substantial. With current demand running from 11 to 12 per cent higher than last year and with stocks down 10,000,000 bbl., the position of suppliers is doubly improved.

Refined Oil Market Barometer

The sixth advance of ⅛ cent per gallon on Mid-Continent tank-car gasoline prices since the middle of March was firmly entrenched in the market structure this week. Refiners in the Mid-Continent moved to solidify their crude-oil positions by posting advances of 10 cents per barrel as protection against encroachment by northern and eastern purchasers expected to develop when the coastwise transportation shortage becomes more acute.

MID-CONTINENT: Lubricating oils advanced 0.5 to 1 cent per gallon.

GULF COAST: Prices steady and firm. Lubricants advanced 0.5 cent.

CALIFORNIA: Residual fuel oils strong. Gasoline unchanged.

PENNSYLVANIA: Gasoline, wax and neutral oils firmer.

CHICAGO: Heating oils and residuals strong. Gasoline demand brisk.

Bright Stocks Up 1 Cent

Mid-Continent bright stocks were advanced 1 cent per gallon and neutrals were elevated 0.5 to 1 cent per gallon, depending on viscosity. Blended oils were raised 0.5 to 1 cent. The advance in Mid-Continent lubricating oils followed similar gains in the Pennsylvania market.

Natural gasoline is strong at 3¼ cents per gallon in the Oklahoma (Group 3) market. Supplies are in approximate balance with demand, a position maintained in this season of slack consumption by virtue of sales contracts executed last winter with crude buyers who move the product in blend to refineries. Manufacturers of natural gasoline in North Texas are quoting 3 cents per gallon on 26-70 material. There too, the market is firm.

Residual fuel oil is in strong demand from contract customers in the northern states where industry is consuming larger than normal quantities because of activity related to the defense program. Railroads are attempting to increase purchases of residual-type fuels but numerous suppliers in this refining section are sold up to capacity.

Ceiling Removed in Certain Eastern Fuel-Oil Contracts

By J. P. O'DONNELL

NEW YORK, May 20.—One of the first effects of the possible shortage of petroleum products on the East Coast to become apparent is elimination of maximum prices in some types of heating-oil contracts. Suppliers are apparently reluctant to commit themselves beyond November 1 by which time it will be indicated whether or not a serious shortage of fuel oil will develop.

One type of contract submitted to consumers specifies a top price of 7.6 cents per gallon, delivered, up to October 31. No maximum is specified for the remaining 7 months of the period in which the contract would be in effect. Another type reportedly relieves the supplier of responsibility of maintaining supplies if a shortage materializes.

If a shortage of petroleum supplies develops on the East Coast it will not be serious until the heating-oil season is in full swing, according to most observers. At that time movement from the Gulf Coast reaches its normal peak. The crisis will be reached in the peak season if one develops. Weather conditions are likely to be a determining factor and if they approximate those of the winter of 1939-40 when fuel-oil consumption broke all previous records by a large margin, the ability of the industry to meet demand in face of reduced transportation facilities will be severely tested.

A policy similar to that governing heating-oil contracts issued during the past 10 days is expected to govern residual-fuel-oil contracts. Bunker C fuel-oil contracts issued last summer carried a top price of $1.25 for most of the season. Demand for residual oil is expected to reach new heights this year. Consequently, a considerably higher maximum price or no ceiling at all will be specified. It is also probable that some agreements, similar to the heating-oil contracts, will carry an escape clause relieving the supplier in the event of inadequacy of supplies.

The position of all products on the East Coast continued to strengthen last week though upward price revisions were comparatively few. Heating oil, diesel and residual oil were unchanged but gasoline was quoted higher at a number of points along the seaboard.

Tank-car quotations on 72-74 octane gasoline in the New York Harbor area were raised 0.5 cent by a majority of suppliers and current ruling prices are from 7.5 to 8 cents per gallon. Some material is said to be available at the previous low of 7 cents but the policy of some companies to protect available supplies as much as possible will undoubtedly quickly clear the market of low-priced material.

The tank-car price of 72-74-octane motor fuel was advanced at a number of North Atlantic points as well as in the New York Harbor area. Minimum quotations at Boston, Mass., and Providence, R. I., were raised to 8.2 cents and at Portland to 8.3 cents, an advance of 0.8 cent in each instance, and at Philadelphia to 8 cents, an increase of 0.5 cent.

Speculative buying has been a factor in the East Coast gasoline-market improvement as well as the sounder statistical position reflected in increasing demand and declining stocks. Oil companies continue to report increased sales of motor fuel but the gain over last year, pronounced in the early part of this year, is not expected to continue so steep. This is due to the fact that adverse weather retarded gasoline consumption in the first quarter last year and to the fact that higher prices are generally in effect throughout the East.

The American Petroleum Institute reports average price of gasoline on May 1 in 50 representative cities was 13.11 cents per gallon as compared with 12.42 cents on April 1 and with 12.91 cents on May 1, 1940. The average price will undoubtedly be higher on June 1 as the result of the widespread advances effected during May but, it is pointed out, it will still be substantially below predepression levels and far below other commodities in price recovery.

Stocks of gasoline dropped only 23,000 bbl. on the East Coast during the week ended May 10 in contrast to a reduction of more than 600,000 bbl. in the previous week. Light-fuel-oil stocks were boosted more than 500,000 bbl. in the same week but while encouraging, this rate of advance must be speeded up considerably during the remaining 20 weeks to the first of October if sufficient supplies are to be on hand when the heating-oil season commences. Stocks of residual fuel oil fell 145,000 bbl. in the same week.

Marketers, encouraged by the small decline in stocks during the week ended May 10, express confidence in the belief that there will be no restrictions on gasoline use during the summer. Current East Coast gasoline stocks are approximately 20,000,000 bbl.

The general tightness of the East Coast market communicated itself to lubricating oils and wax and further indications of increases in Pennsylvania bright stock and neutrals were in evidence. Pennsylvania neutral of 200 viscosity was reported held for 30 cents and 180 neutral, 28 cents. Bright stock was advanced 1 cent to 18 cents.

Wax of both 124-26 and 122-24-melting-point grades is held for a minimum of 3.5 per pound and some suppliers are asking up to 3.75 for the higher melting-point grades. Fully refined grades remained quoted at from 5.6 to 6.4 cents per pound depending on the melting point.

Coastal Lubes Advanced; Other Products Steady

HOUSTON, Tex., May 19.—While general inactivity continued to prevail in Gulf Coast refinery markets, quotations on most products were maintained at former levels. Sellers with material on hand are inclined to withhold any reduction in prices since only a small amount of new business could be developed, and it is doubtful if this could be moved due to the shortage of tankers.

Sales continued to be limited to buyers with boats on hand for immediate shipments and the few inquiries received during the week were still unfilled. High-octane gasolines continued to be quoted at a minimum of 5¾ cents with other grades holding their respective price levels. Quotations on Bunker C fuel still remained from 85 to 90 cents in cargoes.

Effective June 6, lubricating oils moving under contract will be advanced 0.25 to 0.5 cent which is in line with the recent strengthening of prices in the East. Spot sales on all pale oils will be quoted at the higher prices.

While No. 2 fuel oil is reported to have been offered at 3 cents no sales at this figure could be confirmed and material was generally quoted at a range from 3⅛ to 3¼ cents.

New prices for pale oils are as follows: 100, 5¼ cents to 5¾ cents; 200, 7¼ cents to 7¾ cents; 300, 7¾ to 8¼ cents; 500, 8½ to 9 cents; 750, 8¾ to 9¼ cents; 1,200, 8⅞ to 9⅜ cents; 2,000, 9 to 9½ cents; 3,000, no change.

A.P.I. Weekly Refinery Statistics

Week Ended May 17, 1941

	Capacity reporting (per cent)	Total gasoline stocks (bbl.)	Residual fuel-oil stocks (bbl.)	Gas oil and distillate stocks (bbl.)	Daily crude runs (bbl.)
East Coast	100.0	20,587,000	8,156,000	8,879,000	570,000
Appalachian	91.0	2,852,000	476,000	337,000	127,000
Ind., Ill., and Ky.	90.2	17,852,000	3,429,000	2,758,000	637,000
Okla., Kans., and Mo.	76.9	8,330,000	1,913,000	1,257,000	288,000
Inland Texas	59.6	2,318,000	1,415,000	354,000	146,000
Texas Gulf	89.2	15,064,000	6,815,000	5,620,000	923,000
Louisiana Gulf	97.6	3,435,000	1,752,000	1,168,000	137,000
N. Louisiana and Ark.	51.5	533,000	476,000	313,000	52,000
Rocky Mountains	56.0	1,706,000	509,000	144,000	43,000
California	87.3	15,560,000	67,471,000	10,427,000	547,000
Total reported	86.2	88,237,000	92,412,000	31,257,000	3,470,000
Est. unreported	.....	6,630,000	1,575,000	625,000	335,000
*Est. total	.....	†94,867,000	93,987,000	31,882,000	3,805,000
*Est. total previous wk.	.....	95,703,000	94,407,000	31,548,000	3,821,000
*May 18, 1940	.....	102,167,000	102,785,000	26,706,000	3,665,000

*Bureau of Mines. †Includes 7,252,000 bbl. aviation stocks.

Stocks of Crude Oil in the United States

(BUREAU OF MINES ESTIMATE)

Week ended May 10, 1941	263,994,000 barrels
Week ended May 3, 1941	265,728,000 barrels
Week ended May 11, 1940	257,079,000 barrels

Figures do not include stocks of heavy, unrefinable California crude.

RETAIL OIL MARKETS...

Tank-wagon and filling-station prices on gasoline and kerosene furnished by larger marketing firms

Prices as of May 20, 1941

Taxes

The gasoline quotations given in the following tables include the 1½-cent federal tax, as well as state, county, and city taxes. The gasoline is the regular or standard grade. In most areas lower grades and a premium grade also are available.

Standard Oil Co. (Indiana)

	Gasoline Tank wag.	Gasoline Dlr.	Gasoline Inc. tax	Kero. tank wag.
Chicago, Ill.	15.1	13.1	4.5	10.0
Decatur	15.1	13.6	4.5	8.5
Joliet	16.1	14.6	4.5	10.0
Peoria	16.1	13.7	4.5	10.0
Quincy	15.9	14.4	4.5	9.8
Davenport, Ia.	16.1	14.6	4.5	10.0
Des Moines	15.9	13.4	4.5	9.8
Mason City	16.3	14.8	4.5	10.2
Duluth, Minn.	17.9	16.4	5.5	10.8
Mankato	17.5	16.0	5.5	9.9
Minneapolis	17.5	15.0	5.5	10.4
LaCrosse, Wis.	17.5	16.0	5.5	10.4
Green Bay	17.9	16.4	5.5	10.8
Milwaukee	17.3	15.8	5.5	10.2
Detroit, Mich.	15.1	13.6	4.5	9.1
Grand Rapids	15.4	13.9	4.5	9.1
Saginaw	15.4	13.9	4.5	9.1
Evansville, Ind.	17.1	14.9	5.5	9.8
Indianapolis	17.3	15.3	5.5	10.0
South Bend	17.3	15.8	5.5	10.0
Fargo, N. D.	18.7	17.2	5.5	11.6
Huron, S. D.	18.0	16.5	5.5	10.9
Kansas City, Mo.	13.9	12.4	4.5	8.6
St. Louis*	15.2	11.7	4.5	9.6
St. Joseph	15.4	13.5	4.5	8.4
Wichita, Kans.	14.3	12.0	4.5	7.2

*State tax 2 cents, 1-cent city tax, and 1½-cent federal tax.

Exclusive of state general sales taxes.

Discounts to commercial consumers. On purchases per month off tank-wagon prices: 1,000 gal, or more, 1.5 cents off, minimum delivery 25 gal.

Stanolex Fuel Oil in Chicago

Effective Apr. 19, 1941, f.o.b. Chicago, tank-wagon prices: Standard heater oil, 1-99 gal., 8.75 cents; 100-149 gal., 7.75 cents; 150 gal. and over, 7.25 cents. Stanolex fuel oil No. 1, 1-99 gal., 8.5 cents; 100-149 gal., 7.5 cents; 150-399 gal., 7.25 cents; 400 gal. and over, 6.75 cents. Stanolex furnace oil, 1-99 gal., 8.5 cents; 100-149 gal., 7.5 cents; 150-399 gal., 7.25 cents; 400 gal. and over, 6.75 cents. Stanolex fuel oil A, 1-99 gal., 7.5 cents; 100-399 gal., 6.5 cents; 400-749 gal., 5.5 cents; 750 gal. and over, 4.75 cents. Stanolex fuel oil B, 1-99 gal., 7.5 cents; 100-399 gal., 6.5 cents; 400-749 gal., 5.5 cents; 750 gal. and over, 4.75 cents. Stanolex Bunker C fuel oil, 1-399 gal., 6.0 cents; 400-999 gal., 5.0 cents; 1,000 gal. and over, 4.0 cents.

Ohio

STANDARD OIL CO. OF OHIO

	Gasoline Cons'r tank wag.	Gasoline Divided dlr.	Gasoline Inc. tax	Kero. tank wag.
Ohio points	16.0	15.0	5.5	*9.0

*Includes state tax of 1 cent.

Southern District

STANDARD OIL CO. (KENTUCKY)

	Gasoline Cons'r tank wag.	Gasoline Net dlr.	Gasoline Inc. tax	Kero. tank wag.
Atlanta, Ga.	16.5	16.5	7.5	10.0
Augusta	17.0	17.0	7.5	9.5
Macon	16.5	16.5	7.5	9.0
Savannah	16.0	16.0	7.5	9.0
Birmingham, Ala.	17.0	17.0	8.5	8.0
Mobile	17.5	17.5	9.5	8.0
Montgomery	18.5	18.5	9.5	10.0
Jackson, Miss.	16.5	16.5	7.5	9.0
Vicksburg	16.0	16.0	7.5	8.5
Jacksonville, Fla.	17.0	17.0	8.5	8.0
Miami	17.0	17.0	8.5	8.0
Pensacola	17.5	17.5	9.5	8.0
Tampa	17.0	17.0	8.5	8.0
Lexington, Ky.	16.0	16.0	6.5	9.0
Covington	14.0	14.0	6.5	9.0
Louisville	15.5	15.5	6.5	8.5
Paducah	16.0	16.0	6.5	8.5

Price basis to tank-wagon consumers, effective January 4, 1937, 3 cents per gallon below tank-wagon price.

Montgomery, Ala., has a county tax of 1 cent per gallon, and a city tax of 1 cent per gallon on gasoline, in addition to state tax, and 1 cent per gallon on kerosene. Mobile, Ala., has a city gasoline tax of 2 cents per gallon; Birmingham, Ala., has a city gasoline tax of 1 cent per gallon; Pensacola, Fla., has a city gasoline tax of 1 cent. All are included in the table.

Atlantic Coast District

STANDARD OIL CO. OF NEW JERSEY

	Gasoline Cons'r tank car	Gasoline Dlr. tank wag.	Gasoline Inc. tax	Kero. tank wag.
Atlantic City	12.40	13.40	4.5	7.8
Newark	12.40	13.40	4.5	7.8
Annapolis, Md.	13.35	14.85	5.5	9.5
Baltimore	12.75	14.25	5.5	8.5
Cumberland	14.15	15.65	5.5	10.0
Washington, D. C.	11.00	12.5	3.5	9.0
Danville, Va.	14.45	16.95	6.5	9.75
Norfolk	13.25	15.75	6.5	9.5
Petersburg	13.55	16.05	6.5	10.5
Richmond	13.55	16.05	6.5	10.5
Roanoke	14.75	17.25	6.5	10.0
Charles'n, W. Va.	14.55	17.05	6.5	11.5
Parkersburg	13.85	16.35	6.5	11.2
Wheeling	14.85	16.40	6.5	11.8
Charlotte, N. C.	16.80	18.30	7.5	10.1
Hickory	17.35	18.85	7.5	10.0
Mount Airy	17.20	18.70	7.5	10.7
Raleigh	16.55	18.05	7.0	10.0
Salisbury	16.85	18.35	7.5	10.4
Charleston, S. C.	14.65	17.15	7.5	9.25
Columbia	15.50	18.00	7.5	(*)
Spartanburg	16.20	18.70	7.5	(*)

Price basis to Essolene undivided dealers: Dealer tank-wagon price less 0.5 cent per gallon. Price basis to commercial consumers, effective March 8, 1937, in Maryland, District of Columbia, and in Arlington and Fairfax counties in Virginia and March 12 in New Jersey: To contract accounts purchasing at least one full compartment at a time by hose connection, on yearly purchases: From 2,500 to 100,000 gal., consumer tank-wagon price at time and place of delivery: 100,000 gal. per year, consumer tank-car price plus 0.5 cent per gallon. Consumer tank-wagon price generally will be equivalent to dealer tank-wagon price less 0.5 cent per gallon.

Effective January 16, 1939, in North Carolina the commercial consumer schedule became as follows: Single deliveries of 50 gal. or more, consumer tank-wagon price. Single deliveries of less than 50 gal., 4 cents per gallon over consumer tank-wagon price. Generally the posted consumer tank-wagon price will be equivalent to the dealer price, less 0.5 cent per gallon. The above policy also applies in South Carolina, effective January 23, 1939.

*Kerosene business of the company at these points now exclusively handled by dealers.

New York and New England

SOCONY-VACUUM OIL CO., INC.

	Gasoline Cons'r tank car	Gasoline Dlr.* tank wag.	Gasoline Inc. tax	Kero. tank wag.
Albany	14.5	14.7	5.5	7.6
Met. New York	14.1	14.5	5.5	7.9
Buffalo	14.8	15.0	5.5	8.0
Rochester	15.4	15.6	5.5	8.8
Syracuse	15.1	15.3	5.5	8.7
Portland, Me.	14.9	15.1	5.5	8.0
Manchester, N. H.	15.9	16.1	5.5	8.9
Burlington, Vt.	15.5	15.7	5.5	8.2
Boston, Mass.	13.5	13.7	4.5	7.9
Worcester	14.1	14.3	4.5	8.0
Hartford, Conn.	14.2	14.4	4.5	7.5
New Haven	13.6	13.8	4.5	6.8
Providence, R. I.	13.6	13.8	4.5	7.7

*Undivided.

Effective August 8, 1940, the company changed its commercial consumer policy in New York and New England to the following:

Full compartment deliveries: Accounts buying less than 20,000 gal. annually, 0.5 cent above the commercial-consumer price; accounts buying from 20,000 to 120,000 gal. annually, commercial-consumer price; accounts buying 120,000 gal. annually and above, 0.25 cent off consumer price. Split compartment deliveries: Delivery of less than a full compartment, 250 gal., commercial-consumer price plus 1 cent. Steel-barrel deliveries: Commercial price plus 3 cents.

Pennsylvania and Delaware

ATLANTIC REFINING CO.

	Gasoline Cons'r tank car	Gasoline Dlr. tank wag.	Gasoline Inc. tax	Kero. tank wag.
Philadelphia, Pa.	13.5	14.5	5.5	10.0
Pittsburgh	14.0	15.5	5.5	10.5
Allentown	14.0	15.5	5.5	10.5
Erie	13.5	15.5	5.5	10.0
Scranton	14.0	15.5	5.5	10.5
Altoona	14.0	15.5	5.5	10.5
Dover, Del.	...	15.0	5.5	10.5
Wilmington	...	14.5	5.5	10 0

Price basis to undivided dealers, dealer tank-wagon price less 0.5 cent per gallon.

Discount on kerosene, 2 cents per gallon off tank-wagon price on tank-wagon deliveries of 25 gal. or more at one time.

Pacific Coast Territory

STANDARD OIL CO. OF CALIFORNIA

	Gasoline Tank truck	Gasoline Serv. sta.	Gasoline Inc. tax	Kero. tank wag.
San Francisco	17.0	18.0	4.5	11.5
Los Angeles	16.5	17.5	4.5	10.0
Fresno, Calif.	18.0	19.0	4.5	12.5
Phoenix, Ariz.	21.0	22.0	6.5	*17.5
Reno, Nev.	20.0	21.0	5.5	13.5
Portland, Ore.	19.5	20.5	6.5	13.5
Seattle, Wash.	19.5	20.5	6.5	13.5
Spokane	21.0	22.0	6.5	16.5
Tacoma	19.5	20.5	6.5	13.5

*Includes 5-cent state tax.

Discount to dealers: On gasoline, off tank-wagon price, to 100 per cent dealers, 3 cents. To commercial consumers: On tank-wagon price; on single deliveries of 40 gal. and over, advance quantity discount extended at time of delivery, 3 cents. Service-station schedule applies on single deliveries less than 40 gal. On kerosene in tank-car, transport-truck, and trailer delivery, 3 cents off tank-wagon price; plant deliveries to jobbers, 2.5 cents below tank wagon.

March 18, 1939, split dealer discount was canceled.

Rocky Mountain District

CONTINENTAL OIL CO.

	Gasoline Tank wag.	Gasoline Inc. tax	Kero. tank wag.
Denver, Colo.	14.0	5.5	10.5
Grand Junction	17.5	5.5	12.0
Pueblo	14.0	5.5	9.0
Casper, Wyo.	16.5	5.5	11.5
Cheyenne	15.5	5.5	11.0
Billings, Mont.	17.5	6.5	12.0
Butte	16.5	6.5	13.0
Great Falls	16.5	6.5	12.0
Helena	16.5	6.5	12.5
Salt Lake, Utah	17.0	5.5	14.0
Boise, Idaho	†19.6	6.5	16.0
Twin Falls	†20.6	6.5	16.5
Albuquerque, N. M.	*17.0	7.0	9.5
Roswell	*15.0	7.0	8.0
Santa Fe	‡17.5	7.5	9.5

*Includes city tax of 0.5 cent. †Includes toll-bridge tax of 1 mill. ‡Includes city tax of 1 cent.

Tank wagon represents price to consumers. Dealer represents price to dealers. If no dealer price is quoted, the tank-wagon price applies to all classes of trade.

Central South District

STANDARD OIL CO. OF LOUISIANA

	Gasoline Cons'r tank car	Gasoline Dlr. tank wag.	Gasoline Inc. tax	Kero. tank wag.
New Orleans, La.	15.25	17.25	8.5	‡10.0
Baton Rouge	15.25	17.25	8.5	‡10.5
Alexandria	15.25	17.25	8.5	‡10.5
Lafayette	15.50	18.00	8.5	‡10.0
Lake Charles	15.50	18.00	8.5	‡10.0
Shreveport	14.50	17.00	8.5	10.0
Knoxville, Tenn.	18.00	20.50	8.5	12.5
Memphis	15.50	18.00	8.5	10.5
Chattanooga	17.50	18.50	8.5	12.0
Nashville	17.00	18.75	8.5	10.0
Bristol	18.25	18.25	8.5	12.0

Essolene at dealer price less 0.5 cent per gallon to undivided dealers.

‡Includes 1-cent state tax.

Price basis to commercial consumers: Effective May 15, 1937, deliveries of 50 gal. or more in one territory take posted consumer tank-wagon price. Accounts taking deliveries of less than 50 gal. at one time pay posted consumer tank-wagon price plus 4 cents per gallon. Generally, the posted consumer tank-wagon price will be equivalent to the dealer price less 0.5 cent per gallon. Kerosene prices include 1-cent state tax.

Effective February 24, 1939, the company reestablished in New Orleans the commercial consumer policy on motor fuel effective in the rest of the state.

Effective December 12, 1938, the company revised its commercial consumer policy on motor fuel in New Orleans, as follows: Single deliveries of less than 50 gal., consumer tank car plus 2 cents per gallon 50 to 199 gal., consumer tank car plus 1 cent per gallon; 200 gal. and over, consumer tank car plus 0.5 cent per gallon.

Oklahoma and Arkansas

CONTINENTAL OIL CO.

	Gasoline Tank wag.	Gasoline Incl. tax	Kero. tank wag.
Texarkana, Ark.	14.0	5.5	6.0
Fort Smith	14.0	5.5	6.5
Little Rock	17.25	8.0	8.0
Muskogee, Okla.	13.00	5.5	7.0
Oklahoma City	12.50	5.5	7.0
Tulsa	12.50	5.5	7.0

Tank wagon represents price to consumers. If no dealer price is quoted, the tank-wagon price applies to all classes of trade.

Nebraska

STANDARD OIL CO. OF NEBRASKA

	Gasoline Tank wag.	Gasoline Dlr.	Gasoline Incl. tax	Kero. tank wag.
Omaha	17.9	13.4	6.5	9.8
McCook	17.5	14.9	6.5	8.5
Norfolk	18.0	16.4	6.5	9.9
North Platte	18.3	16.5	6.5	10.2
Scottsbluff	17.4	15.5	6.5	9.5

Discounts to commercial consumers for tank-wagon deliveries covered only by standard commercial consumers contract, effective January 1, 1935.

Texas

	Gasoline Tank wag.	Gasoline Serv. sta.	Gasoline Incl. tax	Kero. tank wag.
Dallas, Tex.	11.5	15.5	5.5	6.0
Fort Worth	11.5	15.5	5.5	7.0
Houston	12.0	16.0	5.5	8.0
San Antonio	12.5	17.0	5.5	8.0

Naphtha

STANDARD OIL CO. (INDIANA)

	Tank wagon*
Oleum spirits	16.2
V.M.&P. naphtha	16.5
Cleaners' naphtha	15.5
Stanisol	15.5

*Prices include 3-cent Illinois tax but not 1-cent federal tax nor 2 per cent retail occupational tax.

Prices f.o.b. Chicago. Each price subject to discount of 1 cent per gallon for 150-gal. lots if covered by contract.

Canada*

3-Star Imperial Gasoline
IMPERIAL OIL, LTD.

	Gasoline Tank wag.	Gasoline Incl. tax	Kero. tank wag.
Halifax, N. S.	24.5	10.0	18.0
St. John, N. B.	24.5	10.0	18.0
Montreal, Que.	24.0	8.0	16.5
Toronto, Ont.	24.5	8.0	17.0
Hamilton, Ont.	24.5	8.0	17.0
Winnipeg, Man.	27.5	7.0	22.5
Brandon, Man.	28.0	7.0	22.5
Regina, Sask.	25.0	7.0	20.0
Saskatoon, Sask.	20.8	7.0	22.8
Edmonton, Alta.	25.9	7.0	20.0
Calgary, Alta.	23.0	7.0	18.0
Vancouver, B. C.	21.0	7.0	23.0

*Imperial gallon used in Canada.

Divided dealers pay tank-wagon prices. Discount to undivided dealers, 1 cent below tank-wagon price. In Maritime Provinces both divided and undivided dealers pay tank-wagon price.

Tank-Wagon Changes

Continental Oil Co. advanced the tank-wagon price of regular gasoline 0.5 cent per gallon at Texarkana, Fort Smith and Little Rock, Ark., effective April 26.

Standard Oil Co. (Indiana) reduced the dealer price of regular gasoline 1 cent May 8 at Des Moines, Iowa, and reduced the dealer quotation 0.8 cent per gallon May 9 at Wichita, Kans. The tank-wagon price at Kansas City, Mo., was reduced 0.5 cent per gallon May 15.

Standard of Indiana reduced the dealer price of gasoline 2 cents per gallon May 15 at St. Louis, Mo.

PRICES OF REFINED PRODUCTS...

All quotations f.o.b. plant in cars for interstate or export movement except as otherwise noted

Prices as of May 20, 1941
(Most prices in cents per gallon)

The quotations are exclusive of the federal excise taxes of 1 cent a gallon on gasoline and 4 cents a gallon on lubricating oils. Octane ratings in Middle West, Mid-Continent, and Southwest are based on A.S.T.M. method of testing.

Refinery Gasoline

OKLAHOMA (Group 3)—

U. S. Motor grades:		
72-74 octane (regular)	.05¼	.05½
63-66 octane	.04⅞	.05⅛
60 octane and below	.04½	.04⅝
60-62 400 grades:		
72-74 octane (regular)	.05¼	.05⅜
63-66 octane	.04⅞	.05
60 octane and below	.04⅜	.04⅝

NORTH TEXAS—

U. S. Motor grades:		
72-74 octane (regular)	.05⅛	.05⅜
63-66 octane	.04¾	.05
60 octane and below	.04⅜	.04⅝
60-62 400	.04¼	.05⅛

NORTH LOUISIANA (Ark. and N. La. delivery)—

U. S. Motor grades:		
72-74 octane (regular)	.05⅛	.05⅜
63-66 octane	.04¾	.05
60 octane and below	.04⅜	.04⅝

ARKANSAS (Ark. and N. La. del.)—

U. S. Motor grades:		
72-74 octane (regular)	.05⅛	.05⅜
60 octane and below	.04¼	.04½

CHICAGO (Based on Group 3)—

U. S. Motor grades:		
72-74 octane (regular)	.05¼	.05½
63-66 octane	.04⅞	.05⅛
60 octane and below	.04½	.04⅝
60-62 400 grades:		
72-74 octane (regular)	.05¼	.05⅜
63-66 octane	.04⅞	.05
60 octane and below	.04⅜	.04⅝

PENNSYLVANIA (inland refineries)—

74-76 octane (regular)	.06½	.06¾
80 octane (1939 Research)		.07

CALIFORNIA (domestic movement)—

58-60 400, 65 oct. and higher	.05½	.07
54-58 U.S. Motor	.04¾	.06¼

EAST COAST (domestic)—

U. S. Motor grades:		
New York (Bayonne)*	.06¾	.07
Philadelphia	.06¼	.06¾
Boston	.06½	.06¾
Baltimore	.06	.06¼
Charleston, S. C.	.06½	.06¾

*All grades of gasoline ⅛ to ¼ cent less for barge shipments. New York Harbor prices are for New York and New England delivery. Prices for New Jersey delivery ¼ cent lower.

GULF COAST (domestic)—

U. S. Motor grades:		
72-74 octane (leaded)	.05½	.05¾
70-72 octane (unleaded)	.05¾	.05⅞
68-70 octane (unleaded)	.05½	.05¾
Below 68 octane (unleaded)	.05¼	.05½

Natural Gasoline

OKLAHOMA (Group 3)—

Grade 26-70		.03¼
Grade 18-55		.03¾

NORTH TEXAS—

Grade 26-70		.03
Grade 18-55		.03½

CALIFORNIA—

75-85 375-390	.04½	.05¼

NORTH LOUISIANA (Ark. and N. La. delivery)—

Grade 26-70		.03

Tractor Fuel

OKLAHOMA (Group 3)—

40-42 gr., 315-325 l.b.p., 110-flash, 540-550 e.p.	.03½	.03⅝
41-43 gr., 300-320 l.b.p., 110-125 flash, 500-520 e.p.	.03⅝	.03¾
46-48 gr., 210-230 l.b.p., 480 max., e.p.	.03⅞	.04

Kerosene

(All kerosene water white)

OKLAHOMA (Group 3)—

42-44	.04⅜	.04½
41-43	.04¼	.04⅜

NORTH TEXAS—

41-43	.04⅛	.04¼

NORTH LOUISIANA (Ark. and N. La. delivery)—

41-43	.04⅛	.04¼

ARKANSAS (Ark. and N. La. del.)—

41-43	.04⅛	.04¼

PENNSYLVANIA (inland refineries)—

46	.05½	.05⅝
45	.05¼	.05½

CHICAGO (Based on Group 3)—

42-44	.04⅜	.04½
41-43	.04¼	.04⅜

CALIFORNIA (Pac. Coast market)—

38-40 high-burning test	.04½	.05½

NEW YORK (Bayonne, N. J.)—

41-43		.052

GULF COAST (domestic)*—

41-43		.03⅝

*Barge price ⅛ cent lower.

Furnace Oil

OKLAHOMA (Group 3)—

Range oil	.03⅞	.04⅛
No. 1 prime white, 38-42	.03¾	.04
No. 1 straw, 38-40	.03⅝	.03¾
No. 2 straw, 32-36	.03⅜	.03½
No. 3 zero to 10, 28-32	.03¼	.03⅜

NORTH TEXAS—

No. 1 prime white, 38-42	.03⅜	.03⅞
No. 1 straw, 38-40	.03⅝	.03¾

NORTH LOUISIANA (Ark. and N. La. delivery)—

No. 2, 32-36	.03¼	.03⅜

ARKANSAS (Ark. and N. La. del.)—

No. 2 32-36	.03¼	.03⅜

CHICAGO (Based on Group 3)—

Range oil	.03⅞	.04⅛
No. 1 prime white, 38-42	.03¾	.04
No. 2 straw, 32-36	.03⅝	.03½
No. 3 zero to 15, 28-32	.03¼	.03⅜

NEW YORK (Bayonne, N. J.)—

*No. 1		.052
*No. 2		.047
*No. 3		.047

**Barge deliveries ⅛ to ¼ cent under above tank-car price.

Gas Oil and Fuel Oil

(Gas oil per gal., fuel oil per bbl.)

OKLAHOMA (Group 3)—

U.G.I. gas oil, under 35	.02¾	.03
No. 5, low pour point, 18-22	.80	.85
No. 6, 15 and above, 8-14	.75	.80

NORTH TEXAS—

U.G.I. gas oil, under 35	.03	.03⅛
No. 5, low pour point, 18-22	.80	.85
No. 6, 15 and above, 8-14	.70	.75

NORTH LOUISIANA (Ark. and N. La. delivery)—

10-14 fuel oil, industrial	.70	.75

CHICAGO (Based on Group 3)—

U.G.I. gas oil	.03⅛	.03¼
No. 5, low pour point, 18-22	.80	.85
No. 5, 15 and above, 18-22	.75	.85
No. 6, low pour point, 10-16	.75	.85
No. 6, 15 and above, 8-14	.75	.80

PENNSYLVANIA (inland refineries)—

36-40	.04⅞	.05

CALIFORNIA—

Los Angeles:		
30-40 gas oil, per bbl.	1.10	1.25
24 plus diesel, per bbl.	1.10	1.25
24 plus diesel (bunkers)	1.20	1.35
12-16 bunkers at tidewater)	.75	.85
10-16 (cargo lots)	.75	.85
12-17 (tank cars)	.65	.75
10-17 (high sulfur)	.55	.65
San Joaquin Valley:		
10-18 (tank cars)	.70	.85
24 plus diesel, per bbl.	1.10	1.25
San Francisco:		
24 plus diesel, per bbl.	1.35	1.40
24 plus diesel (bunkers)	1.40	1.50
10-16 (bunkers)	.80	.85

GULF COAST—

No. 2 fuel	.03½	.03¾
43-47 diesel	.03¼	.03⅜
48-52 diesel	.03⅜	.03⅝
53-57 diesel	.03½	.03⅞
58-and-above diesel	.03⅝	.03¾
Diesel bunkers		1.45
Bunker C (bulk cargoes)	.85	.90
Bunker C (bunkers)		.85

NEW YORK (Bayonne, N. J.)—

27 plus, gas oil		.048
28-30 diesel (lighterage 6¼c per bbl.)		1.95
28-30 diesel ((tank cars)		.048
Bunker C (to ocean-going ships in N. Y. Harbor)		1.35
Industrial fuel (tank cars)	.03¼	.03½

Ligtherage charge 5c bbl. additional.

Bright and Steam Refined

OKLAHOMA (Group 3)—

200-210 D, 10-25		.21
150-160 D, 0-10		.16½
150-160 D, 10-25		.16
100-110 D, 0-10		.16
100-110 D, 10-25		.15½
Steam refined:		
600 dark green (untreated)		.10

PENNSYLVANIA—

Bright Stocks (Pennsylvania Grade No. 8 color, 140-150 at 210, 545-550 flash):		
10 pour point		.20½
15 pour point		.19½
25 pour point	.18	.19
Steam refined:		
600	.10½	.11½
650	.10	.13
600 flash	.10	.12
630 flash	.11	.12

Neutral Oil

(Vis. at 100° F. except Pennsylvania and color N.G.A.)

OKLAHOMA (Group 3)—

0-10 pour point:		
150-3		.09½
180-3		.10
200-3		.10
250-3		.11½
280-3		.12
280-4		.11½
300-3½		.13
350-3½		.13½
400-3½		.14
500-3½		.14½
600-3½		.15
100-2½ paraffin oil 10-25		.06
10-25 pour point:		
200-3		.09½
250-3		.11
280-3		.11½
280-4		.11

CALIFORNIA (moving to dom. market)—

Pale oils:		
200-2½-3	.07¼	.08
300-2½-3	.07¼	.08
400-3-4	.07¼	.08
450-3-4	.07¼	.08
550-3-4	.09	.11
600-3-4	.09	.11
Red oils:		
200-4-5	.07¼	.08
300-5-6	.07¼	.08
350-5-6	.09¼	.11½
400-5-6	.09¼	.11½
450-5-6	.09¼	.11½
500-5-6	.09½	.11½
600-5-6½	.09¼	.11½
700-6½ plus	.09¼	.11½
750-6½ plus	.09¼	.11½
900-6½ plus	.09¼	.11½

GULF COAST—

Pale oils:		
100-3	.05¼	.05¾
200-3	.07¼	.07¾
300-3	.07¾	.08¼
500-3½	.08½	.09
750-3½	.08¾	.09¼
1,200-3½	.08⅞	.09⅝
2,000-4	.09	.09½
3,000-4		.10½
Red oils:		
200-5-6	.06⅞	.07
300-5-6	.07¼	.07½
500-5-6	.08	.08¼
750	.08⅜	.08½
1,200-5-6	.08½	.08⅝
100-2½-3	.07¼	.08

PENNSYLVANIA—

150 vis. at 70° F., 3 color, 400-405 flash:		
Zero pour point		.28½
10 pour point		.27½
15 pour point		.26½
25 pour point	.24	.28
200 vis., at 70° F., 3 color:		
Zero pour point		.30½
10 pour point		.29½
15 pour point		.28½
25 pour point	.26	.30

Wax and Petrolatum

(Prices per pound)

OKLAHOMA (Group 3)—

124-126 (A.m.p.) w.c. scale	.03	.03⅛

PENNSYLVANIA (inland refineries)—

122-124 (A.m.p.) w.c. scale	.03¾	.04
124-126 (A.m.p.) w.c. scale	.03¾	.04

NEW YORK—

Wax in bags fully refined:		
125-127 (A.m.p.) wax		.0560
128-130 (A.m.p.) wax		.0560
130-132 (A.m.p.) wax		.0585
133-135 (A.m.p.) wax		.0615
135-137 (A.m.p.) wax		.0640
Crude scale:		
124-126 (A.m.p. w.s.		.03¼
124-126 (A.m.p.) y.s.		.03¼
Petrolatum in barrels, carload lots:		
Dark green	.02500	.02625
Amber	.02375	.02875
Extra amber	.02625	.03250
Lily white	.04375	.05125
Snow white	.05125	.06125
Cream	.03375	.04125

Export Prices

GASOLINE

GULF COAST—

60-62 400	.04⅛	.05⅛
61-63 390	.04⅛	.05¼
64-66 375	.04⅛	.05¼

LOS ANGELES—

U. S. Motor grades:		
Above 69 octane	.05½	.05¾
65-69 octane	.05¼	.05½
60-65 octane	.04½	.05

KEROSENE

GULF COAST—

41-43 water white	.03⅜	.03½

LOS ANGELES—

41-43 water white	.05	.05¼

LUBRICANTS

(Pennsylvania Grade)

NEW YORK (f.o.s. in bbl.)—

Cylinder stocks:	
600 S.R. unfiltered	.18
630 S.R. unfiltered	.18¼
600 flash, S.R.	.18½
650 flash, S.R.	.20
Bright stock:	
Light, 25 pour point	.22

NEUTRAL OIL

200-3 color	.31
150-3 color	.28½

PARAFFIN WAX

NEW YORK (prices per lb.)—

123-125 A.m.p.		.0560
125-127 A.m.p.		.0560
128-130 A.m.p.		.0583
133-135 A.m.p.		.0615
135-137 A.m.p.		.0640
Crude scale:		
124-126 w.s.	.03¾	.04
124-126 y.s.	.03¾	.04

MARKET RECORD OF ACTIVE OIL STOCKS . . .

Compiled by Carl H. Pforzheimer & Co., 25 Broad Street, New York City, Member New York Stock Exchange and New York Curb Exchange

New York Stock Exchange

1941 High	1941 Low	Week ended May 17 High	Week ended May 17 Low	Week ended May 17 Close	Stocks—	Total shares outstanding	Par value	Latest dividend	Payable or last paid	Dividends paid in 1940	Com. sh. earn. 1939	Com. sh. earn. 1938	1940 High	1940 Low	1939 High	1939 Low
55	44	54½	54	54	Amerada Corp.	788,675	N.P.	50cQ	4-30-41	$2.00	$1.56	$2.07	58½	38½	74½	50
24¼	20¾	23¾	23	23½	Atlantic Refining	2,663,999	$25	25cQ	6-16-41	1.00	1.66	1.40	27⅛	18¼	24¾	18⅛
10½	7	7¾	7⅝	7⅝	Barber Asphalt Co.	390,223	$10	25c	5-21-40	.50	1.39	—.85	16⅝	8½	21	10¼
9⅞	7⅝	9¾	8¾	9⅛	Barnsdall Oil Co.	2,558,779	$5	15c	6-9-41	.60	.76	1.26	13⅜	7⅛	19½	11⅛
6⅜	5¼	6⅜	5⅞	6	Consolidated Oil Corp.	13,751,726	N.P.	12½cQ	5-15-41	.72½	.55	.55	8⅛	5½	9⅞	6½
22½	17⅜	22	20¾	21⅝	Continental Oil of Delaware	4,682,572	$5	25cQ	3-31-41	1.00	1.35	1.10	25	16⅛	31½	19⅞
4¾	3½	4¾	4⅛	4½	Houston Oil	1,098,618	$25	....	10-17-30		.43	.83	6⅞	3⅜	9⅜	4½
11⅝	9⅝	11⅛	10¼	10¼	Lion Oil Refining	435,815	N.P.	25cQ	4-15-41	1.00	1.50	2.09	14⅜	9	18⅛	10
16⅞	13	16¾	16⅛	16¼	Mid-Continent Petroleum	1,857,912	$10	40c	6-2-41	.80	1.42	.56	17⅜	11½	18	11⅛
11¾	9⅜	11⅛	10⅜	10½	Mission Corporation	1,378,645	$10	25c	12-20-40	.25	.87	1.04	11¾	7⅛	14⅞	8¾
6⅝	4¼	5⅞	5¼	5¼	National Supply	1,155,517	$10	....	12-22-37	....	—.87	—.79	9¾	4⅝	15½	5⅝
9⅛	6¾	9⅛	8¼	8½	Ohio Oil Co.	6,563,377	N.P.	25c	6-14-41	....	—.10	.25	8¾	5⅜	10½	6
8	5½	7¾	7⅛	7⅛	Pacific Western Oil	1,000,000	N.P.	40c	12-19-39	....	.81	1.22	8⅞	5½	11⅞	7
10⅜	7¼	9¾	9	9½	Pan American Pet. Trans.	4,702,945	$5	25c	12-21-40	.25	1.10	.08	10½	6¾	8¾	5
42¼	35¾	41⅞	39⅞	41¼	Phillips Petroleum	4,449,052	N.P.	50cQ	5-31-41	2.00	2.21	2.03	41¾	27⅛	46½	31¼
16⅞	14¼	16¼	15½	15½	Plymouth Oil Co.	1,038,633	$5	30c	3-31-41	‡1.30	2.38	2.59	22¾	15	24	17⅛
10	7	10	9	9⅜	Pure Oil Co.	3,982,031	N.P.	25c	12-20-40	.25	1.11	.38	11½	6¾	11¾	6⅛
9	7¼	8¾	8¼	8¼	Richfield Oil Corp.	4,010,000	N.P.	50c	12-21-40	.50	.65	.51	9¼	5⅞	10¼	6⅝
15⅝	12½	15⅝	14⅜	14⅜	Seaboard Oil of Delaware	1,244,383	N.P.	25cQ	6-14-41	1.00	1.40	1.52	20	11	24⅜	15½
14½	10⅛	14½	14	14½	Shell Union Oil	13,070,625	N.P.	50c	12-20-40	.75	.77	.72	13⅛	7⅝	17¼	9⅞
28¾	18⅞	28¼	26⅞	27	Skelly Oil	995,349	$15	50c	12-20-40	1.25	1.99	2.27	23¼	12¼	29½	15½
9⅞	8¼	9⅞	9½	9⅝	Socony-Vacuum	31,206,071	$15	25cSA	3-15-41	.50	1.10	1.29	12½	7⅛	15⅛	10¼
23½	17⅞	23⅛	21½	22	Standard Oil of California	13,003,953	N.P.	25cQ	6-16-41	1.00	1.38	2.22	26⅛	16¼	33⅝	24¼
31	25½	30	29½	29¾	Standard Oil (Indiana)	15,272,020	$25	25c	6-16-41	1.50	2.23	1.82	29	20¾	30	22¾
38¼	33	37	36	36	Standard Oil of New Jersey	27,280,998	$25	1.00†	6-16-41	1.75	3.26	2.86	46½	29⅞	53½	38
39	34¼	38¾	38½	38½	Standard Oil of Ohio	753,740	$25	37½c	3-15-41	2.00	6.64	1.81	41¾	26¼	32¾	17
58¾	50	54½	53	54¼	Sun Oil	2,434,863	N.P.	25cQ	6-16-41	*1.00	2.74	1.07	65⅞	46¾	66	45¾
2¼	1⅝	2⅛	1⅞	1⅞	Superior Oil Corp.	1,388,979	$1	10c	12-28-40	.10	.04	.24	2½	1⅛	3⅝	1⅜
40¼	34½	39¾	38⅝	39⅝	Texas Corp.	10,876,139	$25	50cQ	4-1-41	2.00	3.02	2.13	47⅝	33	50¾	32½
4⅛	2⅞	4⅛	3¾	3¾	Texas Gulf Producing Co.	888,147	N.P.	10c	12-14-40	.20	.69	.86	4¼	2½	5⅝	3¼
6¾	5¼	6¾	6¼	6¼	Texas Pacific Coal & Oil	888,236	$10	10c	6-2-41	.40	1.00	1.16	8⅝	5⅜	11⅜	7
10¾	9⅜	10⅜	9¾	10	Tide Water Associated	6,371,827	$10	15c	6-2-41	.70	1.05	1.28	12	8¾	14¼	9½
14⅜	12¾	14⅜	14	14	Union Oil Co. of California	4,666,270	$25	25c	5-10-41	1.00	1.25	1.47	17½	12	19¾	15⅛
29¾	25⅝	28¾	27⅞	27⅞	Union Tank Car Co.	1,177,381	N.P.	50c	6-2-41	1.75	2.07	1.16	29⅞	22¾	24¼	20⅛
2⅜	1⅝	2⅜	2	2	Wilcox Oil & Gas	470,768	$5	10c	2-15-40	...	.77	.52	3⅝	1¾	4¼	2⅜

*Also 5 per cent in stock. †Includes extras. ‡Also 2 per cent in stock. §Also 6 per cent in stock. —Deficit.

New York Curb Exchange

1941 High	1941 Low	Week ended May 17 High	Week ended May 17 Low	Week ended May 17 Close	Stocks—	Total shares outstanding	Par value	Latest dividend	Payable or last paid	Dividends paid in 1940	Com. sh. earn. 1939	Com. sh. earn. 1938	1940 High	1940 Low	1939 High	1939 Low
7⅝	5⅛	7¼	7	7	American Republics Corp.	1,308,049	$10	25c	12-18-40	....	$0.14	$0.22	10¾	4½	11¾	5½
1⅜	1	1⅜	1⅜	1⅜	Bridgeport Machine Co.	263,700	N.P.	$1.25	12-30-37		—.95	—.14	3¼	1⅜	7¼	2½
40¼	36½	38	38	38	Buckeye Pipe Line Co.	200,000	$50	$1	6-14-41	$4.00	3.13	2.36	43	28	34¾	26½
110¼	95¼	97	95¼	95¼	Chesebrough Mfg. Co.	120,000	$25	$1.50Q†	3-31-41	6.00	7.87	5.32	117	95	130	108⅝
5½	3¾	4⅜	4¼	4¼	Cities Service (new)	3,703,978	$10	....	6-1-32	....	.68	.23	6¾	4	9¼	4¼
1½	⅝	1⅜	1¼	1¼	Cosden Petroleum	465,332	$1	....	.....	....	....	....	2⅛	⅝	2¼	½
17¼	12½	17	16⅛	16¾	Creole Petroleum	6,974,356	$5	50cSA†	12-16-40	1.00	1.38	1.64	24¼	11⅝	28	16¾
7¼	3¾	6½	6⅜	6⅜	Darby Petroleum	351,390	$5	25cSA	1-15-39	....	.03	.69	4⅜	2⅞	7⅛	3⅝
1½	1	..	..	..	Derby Oil & Refining	263,162	N.P.	....	.....	.. .	—.37	—.91	2	¾	2⅝	1½
28¾	21¼	..	..	..	Eureka Pipe Line	50,000	$50	50c	5-1-41	2.25	.63	—.37	31	20¼	23	15⅛
35	29	35	33	33⅝	Gulf Oil Corp.	9,076,202	$25	25cQ	4-1-41	1.25	1.69	1.43	39⅞	25⅛	45⅛	29¼
63	52¾	60⅛	58¾	59¼	Humble Oil & Refining	8,987,840	N.P.	37½c	4-1-41	2.00	3.33	3.98	68	47½	71	52½
7	5¾	6⅝	6¼	6¼	Imperial Oil of Canada	26,965,078	N.P.	25c	12-2-40	.62½	.71	.96	12⅜	5⅜	17	11⅝
4	2¾	4	2⅞	3⅝	Indiana Pipe Line	300,000	$7.50	20c	11-15-40	*2.80	.33	.47	7¾	3	7¼	5½
11	8⅞	10⅜	10⅛	10⅜	International Petroleum	14,324,088	N.P.	30c	12-21-40	1.25	1.19	1.98	10¾	8¼	27½	17
2⅝	1¾	..	..	..	Kirby Petroleum Co.	500,000	$1	10c	3-15-41	....	.06	.14	2¾	1⅝	3¾	2⅛
10⅛	8½	9	8⅝	8¾	Lone Star Gas	5,518,347	N.P.	20c	4-22-41	.70	.98	.88	10¾	7⅝	10½	7⅛
5¼	4⅛	5¼	4⅞	4⅞	Louisiana Land & Exp.	2,966,762	$1	10c	3-15-41	.35	.22	.45	6¼	3¾	7¾	4
10	9½	..	..	..	Margay Oil Corp.	149,943	N.P.	25cQ	4-10-41	1.00	1.52	2.28	17	9¼	17	14½
8	7	7⅞	7⅝	7⅝	Midwest Oil Co.	998,474	$10	45c	6-16-41	.90	.99	.93	8½	6½	8¾	6⅝
6⅛	5⅛	5⅜	5½	5½	Mountain Producers	1,593,584	$10	30cSA	6-16-41	.60	.70	.62	6¼	4⅞	6	4⅞
12⅜	10½	10⅞	10½	10½	National Fuel Gas	3,810,183	N.P.	25cQ	1-15-31	1.00	.95	.84	13⅛	10	14	11¼
12¾	10¼	11⅜	11¼	11⅜	National Transit	509,000	$12.50	50c	6-16-41	1.00	.91	.88	12½	8¾	9½	7¼
1¼	1	..	..	..	New Mexico and Arizona	1,000,000	$1	1c	12-1-37	....	.02	.02	1¼	¾	1¾	1
8	6⅝	..	..	..	New York Transit	100,000	$5	30c	5-15-41	.60	.88	.16	7¾	5¼	6	4
9¾	8	..	..	..	Northern Pipe Line	120,000	$10	50c	6-2-41	.80	.31	.24	9⅞	6	7	4½
3⅞	2⅝	3¾	3½	3¾	Pantepec Oil	2,856,872	$1	....	.....	...	....	....	5½	2½	7⅝	4
2¼	1	2	1¾	1¾	Root Petroleum Co.	336,045	$1	25c	2-1-37	....	.70	.17	3¼	1	5	1¼
2½	2⅛	..	..	..	Ryan Consolidated	298,931	N.P.	10c	12-28-40		.16	.29	3	1½	3	1⅞
8	6½	..	..	..	Southern Pipe Line	100,000	$10	25c	3-3-41	.50	.25	—.27	11¾	4¾	4⅞	3½
39¾	36⅛	37	36¾	36¾	South Penn Oil	1,000,000	$25	37½c	3-28-31	2.50	2.84	1.44	44	28	40½	26¾
30½	23	..	..	..	Southwest Penna. Pipe Lines	35,000	$50	50c	4-1-41	6.50	2.06	—.41	35	21	23	18
20⅜	17⅞	18⅝	18½	18½	Standard Oil of Kentucky	2,604,790	$10	25c	3-15-41	1.30	1.53	1.45	20⅞	16½	20⅛	17¼
1⅞	1⅜	1⅞	1¾	1¾	Sunray Oil	1,975,876	$1	5c	12-20-40	.10	.25	.23	2	1⅜	2¾	1¾
3¼	2¾	3	3	3	Texon Oil & Land	936,024	$2	10c	6-28-41	.40	.49	.56	3½	2	4	2⅝
3	2¼	3	2⅞	2⅞	Transwestern Oil Co.	750,000	$10	....	.....	....	—1.42	.12	3⅜	2	6	2½
1/16	1/16	1/16	1/16	1/16	United Gas Corp.	7,818,959	$1	.. .	.....	....	—.55	—.51	2⅛	¾	3⅜	1½

*Includes $2.50 capital distribution. †Includes extras. —Deficit.

Extensive Gasoline Pipe-Line Program Under Way

(Continued from Page 45)

Ohio River and possibly farther west. The Sinclair project still faces some obstacles. However, the company has proceeded with the program to the extent of stacking pipe along the route. This will parallel the lines in the same territory which are operated by Tuscarora Oil Co., Ltd., Keystone Pipe Line Co., and Susquehanna Pipe Line Co. Consideration is being given by a major company to connect the Chicago refining area with Milwaukee and Minneapolis.

Much limelight has been thrown on Georgia and other southeastern states where two major gasoline pipe-line projects are held up because of the stubborn refusal of the Georgia Legislature to correct a technicality which has interfered with acquiring right-of-way by exercising the right of eminent domain. In this section economic considerations differ in some important respects from those found in the active gasoline pipe-line areas in the North which has just been discussed. The Southeastern pipe line (Gulf and Pure), which has not been completed, and the Plantation system (Standard of New Jersey, Standard of Kentucky, and Shell), which has not been started, have been designed to reduce the need for tanker shipments as well as other competitive forms of transportation.

A large part of the gasoline going into Southeastern Pipe Line's territory has been shipped from Texas Gulf Coast ports by tanker around Florida to Savannah, Ga. The economic balance considered in the careful planning of Plantation pipe line will be appreciated through understanding the reasons why this line has been planned to terminate at Greensboro, N. C. The distance along the proposed Baton Rouge-Greensboro route is about half as long as the tanker route around Florida to a convenient seaport. Trucking costs from the coast to Greensboro when added to tanker costs are high enough to make pipe-line deliveries at Greensboro attractive from a competitive standpoint. However, the line may be extended to Norfolk, Va., as a war-time measure. Under present conditions a terminus north of Greensboro does not offer economic advantages. The Plantation line also illustrates an advantage which a gasoline pipe line in that area has over ocean-going tankers. A pipe line can make deliveries economically at intermediate points along the route. Tanker costs are increased to a marked extent when stops are made for deliveries at intermediate ports.

Southeastern Pipe Line Co.'s 450-mile line of 6-in. and 8-in. between Port St. Joe, Fla., and Chattanooga, Tenn., is in operation for less than 100 miles between the coast and Bainbridge, Ga. The remainder of the line cannot be used until legal obstacles have been removed so as to permit laying more than 30 miles of pipe at gaps, most of which occur at highway and railroad crossings.

Plantation Pipe Line

Arrangements have been made with pipe mills for 120,000 tons of pipe for Plantation Pipe Line Co.'s project which will extend from the Standard Oil Co. of Louisiana refinery at Baton Rouge, La., to Greensboro, N. C., with a lateral running as far north as Knoxville, Tenn., and laterals extending south as far as Montgomery, Ala.; Columbus, Ga., and Macon, Ga. It will cross Southeastern Pipe Line near Atlanta, Ga. This would mean employing more than twice as many men as would be required for the usual daylight operations. The line will consist of 793 miles of main line and 467 miles of laterals, making a total of 1,260 miles. As plans have progressed larger pipe sizes have been considered and it is now reported that the line will be built of 12, 10, 8, and 6-in.

Plans for the Plantation line have been going ahead in spite of the fact that, like the Southeastern Pipe Line, it is impeded by the position taken by the Georgia Legislature in the face of protests by President Roosevelt and Secretaries Stimson, Knox and Ickes who urge that these lines be laid as a vital part of the national-defense program. Because of the emergency situation some arrangement may be made between the gasoline line organization, the federal Government and the state authorities in Georgia. The need for these lines becomes more obvious, now that tankers are being requisitioned from oil companies to move American oil for Great Britain.

Opposition to the Plantation project has come from a group of major interests who regard themselves as seriously affected by action of the Government in requisitioning a number of their tankers. The Plantation line, they claim, would put them in an unfavorable competitive position in the territory to be served by the line. During the past week meetings are reported to have been held by these interests to consider laying a 14-in. gasoline line from Texas to Atlantic seaboard points.

The fact that gasoline pipe-line construction in several parts of the country can be pushed on an unprecedented scale by several organizations in these times of shortage and rising prices indicates the firm economic basis which exists for laying lines where they can furnish transportation at lower costs. The prospect of increasing stringency of government regulations in the future adds to the desirability of getting lines in the ground which may prove to be valuable investments for the future.

Cost figures cited in this article show that pipe lines furnish cheap transportation for petroleum products which can compete with tankers, railroads, and trucks under a variety of conditions. There are large areas in the United States where the construction on one gasoline pipe line is bound to lead to the laying of other lines since there is a natural tendency to take advantage of the cheapest form of transportation.

In addition to the 24-in. crude-oil pipe line from Texas and Louisiana points to the East Coast which a group of major companies is contemplating as a cooperative undertaking which would deliver 300,000 bbl., these same interests are discussing another project which would involve the construction of a line of 14-in. to 18-in. diameter between these areas for the transportation of gasoline and refined products. Steps are being taken in Washington, it is reported, to have Congress pass an act which will make it possible for interstate carriers to obtain right-of-way when the needs of the nation require the construction of transportation facilities. Although doubt has been expressed as to the effectiveness of such a law under the Constitution, it is admitted that wartime measures during a period of national emergency may be taken without interference from the courts.

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Pipe Lines Make Preparations for East Texas-New Jersey Shipments

It is expected that a tariff will be published soon to cover the movement of 20,000 bbl. of crude oil daily through a series of pipe lines which Standard Oil Co. of New Jersey is contemplating between East Texas and the company's refineries at Bayway, N. J. Plans under consideration call for starting shipments this month. At the present time lines are being tested at certain points in preparation for this unusual pipeline movement. The hookup includes lines of the following systems: Humble Pipe Line Co., Standard Oil Co. of Louisiana, Oklahoma Pipe Line Co., Ajax Pipe Line Corp., Illinois Pipe Line Co., and Northern Group Pipe Lines.

Prospects for Quick Settlement Of Antitrust Suit Fading

(Continued from Page 43)

conference might be held between government defense officials and the committee.

In addition, Atty. Gen. Robert H. Jackson late last week wrote to Leon Henderson, price administrator, setting forth a four-point program of cooperation between the two agencies.

Mr. Jackson's proposal was as follows:

"1. Whenever you find that prices are being driven up or held up by any method or device which is a probable violation of the antitrust laws, you may certify the case with such information as you have in support of it to this department. The Department of Justice will give such cases priority of investigation and prosecution and will at once begin investigation by the Federal Bureau of Investigation, the staff of the antitrust division and, in appropriate cases, by grand juries.

"2. Proposals of civil or criminal proceedings under the antitrust laws may, before authorization by me, be submitted to you for advice as to whether the proposed action would have any adverse effect on your price-stabilizing efforts and, if not, as to whether because of its effect on your work, the case should be conducted as a preferred case. I will determine authorizations and classifications after receiving your advice, which I hope you can arrange to furnish with expedition.

"3. Proposals of price action by you may be submitted to this department for an expression of advice as to the effect on any pending or contemplated proceedings or for information as to the industry which may be in the possession of this department.

"4. In matters not covered by this arrangement, such as preferences among pending cases in this department, we will establish informal cooperation with your office."

These steps, Mr. Jackson said, should substantially aid in strengthening civil protection and achieving greater stability during the present emergency.

●

Electrical Engineers Will Meet In New Orleans in December

The American Institute of Electrical Engineers will hold its southeastern district meeting in New Orleans, La., on Wednesday, Thursday, and Friday, December 3, 4, and 5, 1941. The headquarters will be at the St. Charles Hotel where the Louisiana Engineering Society maintains its club rooms and library.

Those in charge are as follows: James T. Todd, general chairman; Eugene Mabson, technical papers; Frank G. Frost, meetings and entertainment; Louis T. Frantz, plant visitation, and Robert J. Kuhn, publicity.

Eugene Mabson is chairman of the New Orleans section and Frank Johnson, secretary.

A very interesting technical program, together with visits to many of the varied industrial plants of New Orleans, is being arranged. In addition there will be varied entertainment offered both for the members and their wives.

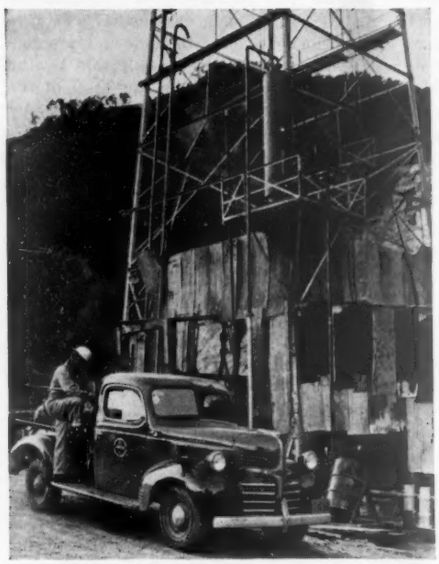
Aetna Will Lay to Mount Vernon, Ind.

Aetna Oil Co. of Louisville, Ky., will lay a 4-in. crude-oil line from the Inman field, Gallatin County, Illinois, across the Wabash River east to a loading terminal at Mount Vernon, Ind., a distance of 14 miles. The line will originate on the Egyptian Tie & Timber Co. leases near Inman where several Tar Springs producers have been completed recently. At present Aetna is trucking the crude to gathering lines.

EQUIPMENT PROGRESS...

Fleet of Dodge Trucks Operated by Johnston Service

"Fire department of the oil industry" is the name that can be applied to a fleet of Dodge trucks operated by the M. O. Johnston Oil Field Service Corp. of Los



Angeles, Calif. On call 24 hours a day and always ready for a rush trip, these trucks speed formation-testing equipment to the site of a drilling well. By means of a scientific test, the contents and productivity of various zones encountered in the drilling operation can be measured without loss of time required for cementing casings. Thus it can be determined instantly whether the well is ready to be cased or should be drilled deeper for a larger quantity of oil.

Ranging in size from ½ to 1½ tons, these Dodge job-rated trucks are constantly speeding to oil fields from the Johnston company's headquarters in Los Angeles and from branch offices in Southern California, Texas, Louisiana and Arkansas. Speed and dependability are essential.

Called the "fire department of the oil industry," the Dodge ½-ton truck pictured above prevents dollars from "burning up." Photo was taken in a new field near Los Angeles, Calif.

Lone Star Introduces New Deep-Well Cement

Paralleling the continuing trend toward deep drilling, the Lone Star Cement Corp. has just announced the introduction of "Texcor" deep oil-well cement. Based on intensive field and laboratory research, this cement was specially developed for use in the deepest wells at the highest temperatures encountered today or likely to be encountered at depths of even 15,000 ft. or more.

Mixed with 40 per cent water, "Texcor" is pumpable in excess of 8 hours at 200° F., thus providing an increased factor of safety in oil-well cementing, and at the same time producing strengths in excess of 5,000 lb. per sq. in. in 24 hours and over 6,000 lb. in 48 hours.

"Texcor" produces more intimate mixtures of cement and water, resulting in free-flowing slurries, lower pump pressures and a greater margin of safety in the cementing operation. Less mixing water is required, permitting the use of heavier, denser slurries with normal pump pressures. This greater pumpability with low-water content is a further factor in producing hardened cement that is denser and stronger.

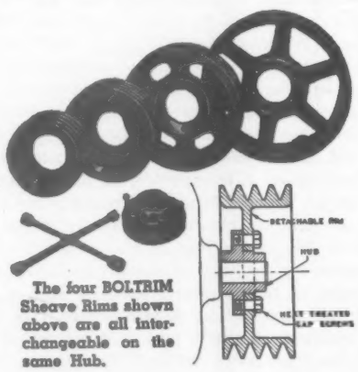
An additional advantage is the fact that during mixing a "Texcor" slurry automatically indicates the presence of excess mixing water by the appearance of excessive surface bubbles in the slurry tub—introducing a safeguard against the use of too much mixing water. In developing "Texcor," the Lone Star oil-well cement research laboratory also had in mind the special problems of squeeze jobs where this longer pumpability, low initial viscosity and maximum density make possible satisfactory results even under the most difficult operating conditions.

Lone Star now produces four cements for oil-field service: "Texcor," for deepest wells and highest temperatures; "Starcor," for deep wells and high temperatures; "Incor," for wells of moderate depth; and Lone Star, for all around oil-field use. For further details about any of these cements, address Lone Star Cement Corp. at either Dallas or Houston, Tex.

Multiple V-Belt Drive Data Book Released

A comprehensive data book covering all types of V-belt drive applications has been compiled and published by the Fort Worth Steel & Machinery Co., Fort Worth, Tex., manufacturer of Boltrim V-belt sheaves and agent for "Goodflex" multiple V-belts. This book, in addition to the usual data, contains full and detailed information concerning the widely used "Boltrim," or demountable hub sheave. Complete specifications together with a list of sizes carried in stock are shown.

According to the manufacturer, a Boltrim sheave is constructed in such a way that rims of varying diameters and face widths can be mounted. The rim is attached to the hub with heat-treated cap screws, mak-



The four BOLTRIM Sheave Rims shown above are all interchangeable on the same Hub.

ing it possible to quickly and easily remove the rim without removing the hub from the shaft. Thus a rim may be replaced with a minimum loss of time. Special tools are not required.

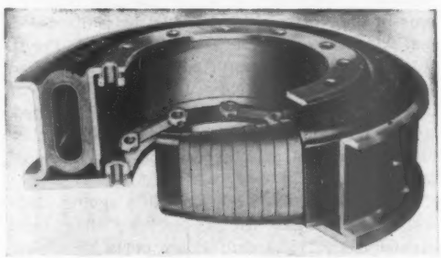
Boltrim sheaves are available in a wide variety of sizes, ranging in diameter from 7.4 in. p.d. to the largest. They may be had with any standard number of grooves and to fit all standard sizes of V-belts. Four hundred and seventy-seven different sizes for A, B, C, and D section V-belts are designated as stock sizes. This almost unlimited range of stock makes it possible to assemble drives from the largest to the smallest and with practically any desired speed ratio.

The 64-page book mentioned above contains, aside from data on Boltrim rims and Goodflex belts, a great amount of useful information on such things as ratios, load capacities, friction losses, etc. It will be mailed free upon request by the company.

Falk Announces New Type Flexible Coupling

The Falk Corp., Milwaukee, Wis., announces a new type of flexible coupling, the Falk "Airflex." This coupling is especially designed for connecting diesel, gasoline, or gas engines to any type of driven machinery. It is an excellent coupling for use with motor-driven compressors, single-cylinder pumps, and other driven equipment of a similar fluctuating torque nature.

The Falk Airflex coupling is built to satisfy the need for a flexible coupling in which the degree of



resiliency can be readily changed to suit the exact requirements of a particular application. It decreases peak torque values when either the prime mover or driven equipment has a high-fluctuating torque characteristic.

The Airflex coupling consists of a special resilient rubber gland lined with a premoulded, prevulcanized cylindrical section especially treated to prevent air loss. This cylindrical lining is covered with multiple alternating layers of tough durable fabric and live rubber. The entire gland is permanently bonded to rugged steel inner and outer rims.

The degree of elasticity in this coupling can be varied by changing the air pressure. This frequently eliminates the necessity for adjusting the setting of the connected units, or making changes in shaft diameters and lengths or in the flywheel, to alter the torsional characteristics of the drive system. Falk Airflex couplings are made in six standard types so that the type best suited to the requirement can be applied with the minimum of special work.

TRADE LITERATURE

HINDERLITER TOOL CO., North Peoria, Tulsa.—Folder describing its rotary side-door junk baskets for fishing operations. This device is a radical departure from the conventional design of "fishing basket" as there are no cutter teeth or catcher fingers embodied in its design.

PITTSBURGH PIPE & COUPLING CO., Allison Park, Pa.—Catalog 41, presenting complete specifications on its large line of pipe couplings and giving general engineering data on pipe couplings and thread standards.

BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa.—Technical Data Card No. 103A, a card folder listing seamless tubing-wall thickness data in milimeters and inches, and comparing the various gages in use today.

MACWHYTE WIRE ROPE CORP., Kenosha, Wis.—4-page folder containing helpful information on wire-rope inspection and illustrates common causes for wire-rope failure. In it several wire-rope constructions are shown with recommendations for use.

GEOPHYSICAL SERVICE, INC., Dallas, Tex.—24-page booklet on geochemical well logging. The booklet describes the geochemical method of analysis and its application to well logging, the purpose of the geochemical well log, when and how to sample and other phases of this method of detecting oil. Several chemlogs are reproduced, illustrating how the hydrocarbon

content of the various samples are plotted to arrive at a complete log for both producers and dry holes. Copies of the booklet, "Geochemical Well Logging" may be obtained from the company.

Brown Announces Circular Chart Potentiometer Pyrometer

The Brown Instrument Co., Philadelphia, Pa., announces the development of a circular chart potentiometer. This is a new type of self-balancing instrument for indicating and recording temperature. It employs the proven null-point potentiometer measuring circuit, but its balancing system is entirely new and different.

The balancing system is continuous. It has no galvanometer. It is unique in speed of response and extremely sensitive to minute temperature changes. All live parts are enclosed. All amplifier components are oversize. Sensitivity may be adjusted for correct operation on any standard pyrometer range, thus making all amplifiers interchangeable. The balancing motor is a brushless, reversible induction motor with built-in gear reduction. Totally enclosed. Has ample power and drives pen, pointer and slide wire.

The rectangular case is of sturdy construction with rigid die-cast door. Streamline cam action combination handle and lock draw door tightly against case. Special baked, durable black enamel finish resists corrosion in moist, salt or acid atmospheres. Universal mounting permits flush or front-of-board mounting. Matches the well known line of Brown rectangular case thermometers, pressure gages and flow meters and combines with them to provide a well-balanced modern appearance when mounted on a panel.

New Ohio Distributor Appointed For Bucyrus-Erie Spudders

The Zanesville Tool & Supply Co., of Zanesville, Ohio, has recently been appointed as distributor for the sale of Bucyrus-Erie oil-well spudders in Ohio. This firm maintains an office and warehouse at Zanesville, with resident salesmen located at Marietta, Newark, and Wooster. B. R. Straker is president of the firm and handles the northern Ohio territory. The new Bucyrus-Erie 36-L and 24-L spudders will be featured by the Zanesville firm.

Boezinger Made Vice President Of Merco Nordstrom Valve Co.

H. Boezinger, for the past number of years district manager in Los Angeles, Calif., of the Pittsburgh Equitable Meter Co., of Pittsburgh, Pa., and the Merco Nordstrom Valve Co., of Oakland, Calif., has been elected a vice president of Merco Nordstrom Valve Co. Mr. Boezinger is a graduate of Stanford University. Prior to his affiliation with Merco Nordstrom. Mr. Boezinger was engaged in petroleum engineering in both the San Joaquin Valley and southern California. He has been associated with the company since its early development and expansion in the oil industry. Mr. Boezinger's additional activities will cover the entire West Coast.

James Coombe Made New President of Powell Company

James Coombe recently was elected president of the Wm. Powell Co., manufacturers of bronze, iron, steel, and corrosion-resistant valves. With the exception of 2½ years, during which time he served overseas as captain in the first World War, he has been associated with the company since his graduation from Yale in 1910. Mr. Coombe is a director of the First National Bank, the Crosley Corp., the Globe-Wernicke Co., and the Randall Corp.

JAMES COOMBE

The Powell company announces also the election of Harry H. Coombe, chairman of the board of directors and treasurer; George E. Weitkamp, first vice president and secretary; David M. Forker, Oliver F. Gang, William E. Heilig, and E. R. Noll, vice presidents; and William E. Minor, Jr., assistant to the president.

AMONG EQUIPMENT MEN...

Two Promotions Announced By Bantam Bearings Corp.

Bantam Bearings Corp., South Bend, Ind., recently announced important changes in its management, due to the resignation of A. H. Frauenthal, formerly vice president and general manager. R. B. Nichols, formerly secretary, has been named vice president and general manager and J. Frank Oelhoffen, who has been serving in the capacity of assistant sales manager, has been moved into the position of Bantam's sales manager.

J. F. OELHOFFEN *R. B. NICHOLS*

This announcement is coupled with the news that Bantam's steadily increasing program of expansion now finds the firm enjoying the most favorable period in its history. Growth in output of all major types of antifriction bearings has been consistently redoubling during the past 10-year period.

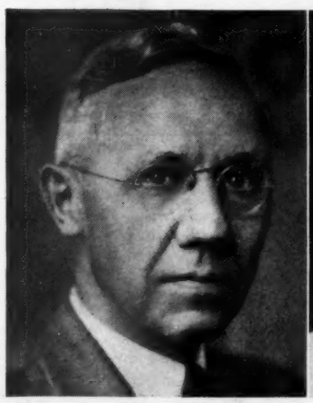
BUSINESS NOTES

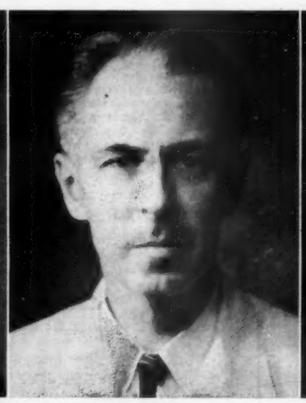
Industrial Tractor & Equipment Co., Inc., of Baton Rouge, La., has been appointed distributor for Bucyrus-Erie ⅜-yd. to 2½-yd. shovels, draglines, clamshell, and lifting cranes. Its territory covers the State of Louisiana except for the parishes around New Orleans and the delta.

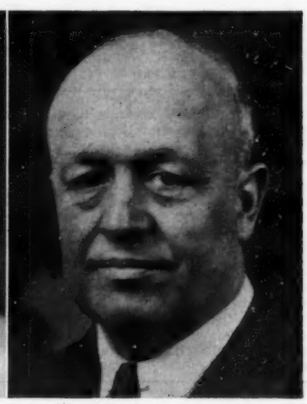
J. E. Skinner was recently placed in charge of welding wire sales, as assistant to W. H. Bleecker, sales manager, at the general sales office of Page Steel & Wire Division, American Chain & Cable Co., Inc., Monessen, Pa., taking over the duties previously performed by V. H. Godfrey who was recalled to active duty with the U. S. Navy. W. G. Hoagland of the Chicago office of Page Steel & Wire Division was transferred to Monessen, Pa., to take over the duties previously handled by Mr. Skinner.

J. L. WOODRESS MADE CENTURY ELECTRIC SALES DIRECTOR

J. L. Woodress has been appointed director of sales for Century Electric Co. of St. Louis, Mo. Mr. Woodress, a native Missourian, attended the Colorado School of Mines and graduated from the University of Missouri in 1904. He spent 3 years with the United Railways of St. Louis before joining the Century organization in 1907. His first assignment was traveling sales and service. He was successively assistant sales manager, sales manager, general sales manager, and now director of sales. He is assistant secretary of the company and has been a member of the board of directors for a number of years.







JAMES L. WOODRESS *EARL S. MOORE* *C. E. WHITE*

Earl S. Moore becomes general sales manager. Mr. Moore graduated from Purdue University in 1915. He spent a short time in central station work before joining Century in 1916, and has been with the company continuously expect for 1½ years with the Marines in 1917-18. After traveling extensively on domestic sales, Mr. Moore became export manager in 1920. The first 10 years of this assignment were spent outside of the United States, establishing and working with agents in the principal centers throughout the world.

C. E. White becomes export manager. Mr. White graduated from the University of Iowa in 1918 and joined the Century organization in 1919. He was employed as a sales engineer and district sales manager until he was sent abroad to London in 1927. He spent 11 years as foreign representative, both in England and on the continent. On his return in 1938 he was successively regional sales manager for the New York and St. Louis zones and now brings this wide experience to his new position.

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Leases and Drilling Blocks

LEASES—East Texas, La., South Ark. 20 acres up, dollar acre up.—Owners—Address Attorney. Box 1122, Little Rock, Ark.

NEW MEXICO
Oil and Gas Leases and Royalties
ROY G. BARTON, Hobbs, N. M.

60 ACRES Semi Proven lease for development, on override bases in Texas. Wells flow. Box A-432, The Oil and Gas Journal, Tulsa, Okla.

FOR SALE: Oil and gas leases and small production located in Kentucky shallow field, also tracts of proven Fluorspar and zinc deposits. Reports on request. W. P. HARLEY, Bowling Green, Kentucky.

MICHIGAN—1,160 acres to lease for Oil and Gas. Map free. Owner: L. J. Meldrum, 8354 Epworth, Detroit, Mich.

VISITING Tulsa end May, would acquire drilling block, royalty, leasehold or purchase in fee, with mineral rights, in undeveloped but proven, or producing gas or oil field. Preferably Hugoton-Amarillo districts. Henry Berger, 41 Central Park West, New York.

FOR SALE: 15-well oil lease; shallow; Bartlesville sand; ideal for water flooding. H. W. Mitchell, Osawatomie, Kans.

WANT drilling deal to develop highly geologized Pine Mountain, Segment Basin and Airport structures in Natrona County. P. O. Box 1162, Casper, Wyoming.

WILL sacrifice for quick sale account of health, Lea County, New Mexico 40 acres each Sections 15 and 21, 17S-36E. Lock Box 126, Vinton, Va.

OIL LEASE near drilling well $500. Geology and title certificate furnished. Address: Owner, Box 1203, Abilene, Tex.

FOR SALE by owner: 80-acre lease with 12 wells located in Section 10, Township 27, Range 13, Washington County, Oklahoma. Write E. A. Hutchinson, P. O. Box 1710, Tulsa. Okla.

MEN WANTED
State Oil & Gas Leases and Landowner's Royalties
Harry S. Wright
Farmington, N. M.

EAST TEXAS Woodbine sand wildcats. Leases offer 10 to 50 for one bets. Getting ready to happen shortly new areas. E. CROFT, PROCTOR, TEXAS.

"Pecos County, Texas, Acreage"
New ten-year lease with twenty-five cent rental covering five thousand acres, Block 104, Jasper County School Land. Cheap if taken at once. Address P. O. Box 372, Jasper, Texas.

FOR LEASE 150,000 ac. in Tennessee's coal basin, on world's largest timbered plateau. Part of Appalachian coal, oil and gas field. Oil being refined here now from shallow wells. Stanolind and other large companies have leases here. G. E. Harrison, Crossville, Tennessee.

WANTED, drilling contractor to drill nearly proven lease for an interest and cash. J. F. Houston, Pawnee, Okla.

FOR LEASE: Oil—About 40,000-acre block in Arkansas. Tests already made highly favorable—indicating good field. Write Bert Larrabee, Box 1435, Houston, Texas.

U. S. OIL RESERVE lands can be filed for lease on limited acreage by American Citizens. Want several join me in filing block in developing Rocky Mountain Area. Big opportunity. Small expense. Box A-346, The Oil and Gas Journal, Tulsa, Okla.

Leases and Drilling Blocks

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Texas, New Mexico, Oklahoma, Louisiana and Illinois
20 Years Experience
Inquiries Invited
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OIL PAYMENT, offering $5,000.00 in Oil for $1,000.00 cash. Limited offering. Investigate now. J. F. Houston, Pawnee, Okla.

WILL consider drilling desirable farmouts or blocks, Tex., Okla., La., Ark., Kans., Ill. American Investment Co., Houston, Tex.

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LOCATIONS with the TRUMBULL INSTRUMENT have proven themselves in various fields. Write for full details before you drill. TERRA SURVEYS, Box 23, Waterloo, Illinois.

Legal Blanks

BURKHART'S legal blanks and generes forms serving Mid-Cont. oil field since 1908—Okla. Kans. N. Mex. Tex. Ala. Ark Fla. Ga. Ill. Ind. Ky. La. Mich. Miss. Mo Neb. N. Dak. Tenn. Wyo. Free catalog samples on request. Burkhart Ptg. & Stn Co., 115 S. Cinn., Tulsa. Oklahoma.

Business Opportunity

INTERESTED financial association 50% either for new enterprise or development of sound existing business connected any branch Oil industry—except drilling and production. Storage or transportation preferred. Box A-492, The Oil and Gas Journal, Tulsa, Okla.

Mailing Lists

ROYALTY owners, Oil Investors, Unit holders, Stockholders in Oil and Royalty Companies. Personnel lists of every branch of oil industry. All by States. We buy lists. New catalogues ready. Oil Industry Mailing List Co., Tulsa Loan Bldg., Tulsa, Oklahoma.

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WE BUY & SELL all types of Oil and Gas Royalties. Sales restricted to registered dealers only. Grimes Royalty Co., Tulsa Loan Bldg., Tulsa, Okla.

I OFFER — Production Royalties in Oklahoma County, Okla. Monthly income. John P. Stouppas, 38 S. Watt Street, Youngstown, Ohio.

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RANCH FOR SALE
14,000 acres with minerals. Watered from 5 creeks, tanks and wells. No better Ranch in Texas. About 80% tillable. On hard surface Highway. Price $20.00 per acre. Address
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Seymour, Texas.

Geologic Survey

U. S. and State lists of Geological publications available FREE upon application. Cornwall's Book Store, 723 11th Street N. W., Washington, D. C.

Equipment Wanted

WANTED: All makes of used Diesel Engines, preferably "Caterpillar" Diesels. Write price, condition and location to Fabick Tractor Co., Box 503, Salem, Ill.

WANTED—100 KVA, A.C., GENERATOR DIRECTLY CONNECTED TO NATURAL GAS ENGINE. MUST BE IN GOOD CONDITION. P.O. BOX 724, AUSTIN, TEX.

Incorporations

DELAWARE CHARTERS: Complete service $35. Submitted forms. Chas. G. Guyer, Inc., Wilmington, Delaware.

CAPITAL SEEKERS
Put your project before 260 Key-Men. Cost trifling. Details free. AMSTER LEONARD, Fox Theater Building, Detroit, Michigan.

Situations Wanted

REFINERY Engineer, Superintendent, Manager. Well experienced in design, construction and operation of modern refinery equipment. Age 41. Box A-480, The Oil and Gas Journal, Tulsa, Okla.

EXPERIENCED REFINERY MANAGER, age 45, chemical engineer, D. Sc. from leading European university (*summa cum laude* degree), 25 years' experience with major companies, thoroughly trained in operation of refineries and manufacture of all mineral oil products. Ability in handling men. Expert in selective extraction processes. Important publications. Efficient and energetic. Five languages. Excellent references. Now employed but desires change. Address Box A-491, The Oil and Gas Journal, Tulsa, Okla.

MATERIAL and Supply Man seeks position in charge of Oil & Gas Field Supplies. Familiar in drilling, production and pipe line work. Also can assume charge of Commissary purchases. Best of references, can give bond. Nothing promotional. Address Box A-490, The Oil and Gas Journal, Tulsa, Okla.

BOOKKEEPER, office man, typist, 28, single, draft deferred, high school graduate, LaSalle accountancy student, 3 years high school Spanish, now employed by Texas wholesale auto supply. Present position 4 years. Present salary $105. Consider foreign service. Box A-501, The Oil and Gas Journal, Tulsa, Oklahoma.

EXECUTIVE with twenty years' practical experience in the oil industry desires connection with reputable company or independent operator. Experience includes land department supervisor, leasing and title work, acquisition of, and development of properties, and general administrative duties. Capable, efficient and diplomatic. Age 42. Box A-500, The Oil and Gas Journal, Tulsa, Oklahoma.

Help Wanted

MACHINIST capable of maintaining Worthington BG and CG gas engines, centrifugal and reciprocating pumps including hot oil pumps, also operation machine shop tools. Refinery experience preferred. Open shop. Box A-472, The Oil and Gas Journal, Tulsa, Okla.

STILLMAN for small refinery. Give references, state age, if married, and wages expected. Terry Carpenter, Inc., Scottsbluff, Nebraska.

DRAFTSMAN with experience in oil refinery design and construction. Location Middle West. State age, education, experience, and salary desired. Box A-473, The Oil and Gas Journal, Tulsa, Okla.

REFINERY OPERATORS WANTED: Stillmen, stillmen's helpers, and others experienced in modern oil cracking plants. Give references and history of experience. Box A-502, The Oil and Gas Journal, Tulsa, Okla.

For Sale—Equipment

FOR SALE—1 Joplin Special 5½ Keystone Cross Mounted Waukesha Power Unit—equipped with calf reel—1 all steel 70 Keystone truck mounted. Both good Rigs. Write W. C. Schnell, Boonville, Mo.

FOR SALE: One Model 61 Wichita Spudder in first class shape and 4,500 ft. of sand line and drill line in good shape. Also, one 125 H.P. Waukesha drilling engine. Phone 6697 or write 3304 Miami, Wichita Falls, Texas.

FOR SALE At Oklahoma City: 12 x 8 x 12 National Transit Fig. 122 Duplex Piston Pump. $250.00. I.T.I.O., Bartlesville, Okla.

STAR SPUDDERS FOR SALE
Due to death of senior member of firm will sell at attractive price for cash or equivalent. Two No. 45 Star spudders with 95-hp. Hercules motors, complete with lines and 4-in., 5½-in. and 7-in. o.d. tools. For inventory, price and inspection, address L. W. Harmon, 400 Colonial Drive, Henderson, Texas.

FOR SALE—2 strings Rotary Tools offered at Bargain Prices. Capable of drilling to 3500 feet. Located on Gulf Coast. Inventory on request. Address inquiries to Box 670, Fort Worth, Texas.

CLASSIFIED ADVERTISING RATES

Classified advertising rates: First insertion, 35 cents a line; each additional insertion, 25 cents a line, PAYABLE IN ADVANCE. Six words usually make a line. Count as a word each one-letter word and each group of figures. White-space computed at regular line rate. Allow two extra lines for blind ads. Ads of less than three lines not accepted. No formal acknowledgment is made, and proofs cannot be shown in advance of publication.

	1 time	2 times	3 times	4 times		1 time	2 times	3 times	4 times
3 Lines	$1.05	$1.80	$2.55	$3.30	7 Lines	$2.45	$4.20	$5.95	$7.70
4 Lines	1.40	2.40	3.40	4.40	8 Lines	2.80	4.80	6.80	8.80
5 Lines	1.75	3.00	4.25	5.50	9 Lines	3.15	5.40	7.65	9.90
6 Lines	2.10	3.60	5.10	6.60	10 Lines	3.50	6.00	8.50	11.00

CLASSIFIED DISPLAY RATES

Classified Display is set with a border and may be used in one or two column sizes.

1 Inch	1 time	$5.00
1 Inch	13 times	4.50 per inch
1 Inch	26 times	4.00 per inch
1 Inch	52 times	3.50 per inch

This space may be contracted for over a period of one year from the date of the first insertion and is PAYABLE IN ADVANCE, MONTHLY.

We reserve the right to withhold all advertising of questionable character. To avoid delay be sure to send remittance with copy. We will set your ad in the smallest amount of space possible and refund all overpayments. One-time insertions will not be run until fully paid. Forms close MONDAY NOON before each issue date.

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Tulsa, Oklahoma